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# THESIS

**A TEN-YEAR LOOK BACK AT THE ASSOCIATION BETWEEN THE GLOBAL WAR ON TERRORISM (GWOT) AND COSTLY MENTAL HEALTH CONDITIONS**

by

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This study analyzes the effects of OEF/OIF deployment (including deployment location, frequency of deployment, and days deployed) on the probability of being diagnosed with Post-Traumatic Stress Disorder (PTSD), schizophrenia and bipolar disorder. The authors examine active duty personnel in all four services of the U.S. armed services since the start of the Global War on Terrorism.

The data are provided by the Defense Manpower Data Center (DMDC) and TRICARE; they include deployment, administrative, and medical information for all active duty service personnel between FY2001 and FY2011 (N=2,800,999). The authors used descriptive statistics, as well as multivariate analysis (probit models), to assess the deployment effects.

Results show that a deployment, especially to Iraq, is associated with an increased probability of being diagnosed with PTSD and that the magnitude of the effect is higher for deployments after 2005 for the Army. Serving in combat-arms specialty fields is also associated with a higher probability of being diagnosed with PTSD among Army and Marine Corps service members. Deployment is associated with a lower probability of diagnosis for bipolar disorder. The total cases of schizophrenia among active duty service members are very low; thus, this condition is excluded from the multivariate analysis.

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# A TEN-YEAR LOOK BACK AT THE ASSOCIATION BETWEEN THE GLOBAL WAR ON TERRORISM (GWOT) AND COSTLY MENTAL HEALTH CONDITIONS

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFSC | Air Force Specialty Codes |
| CAPER | Comprehensive Ambulatory/Professional Encounter Record |
| CBT | Cognitive Behavioral Therapy |
| CPT | Cognitive Processing Therapy |
| CTS | Contingency Tracking System |
| DEERS | Defense Enrollment Eligibility Reporting System |
| DMDC | Defense Manpower Data Center |
| DoD | Department of Defense |
| DSM | Diagnostic and Statistical Manual of Mental Disorders |
| EDIPN | Electronic Data Interchange Person Number |
| EMDR | Eye Movement Desensitization and Reprocessing |
| FFT | Family-Focused Treatment |
| GWOT | Global War on Terrorism |
| ICD-9 | International Classification of Diseases, 9th revision |
| LPM | Linear Probability Model |
| MHS | Military Health System |
| MOS | Military Occupational Specialty |
| MTF | Military Treatment Facility |
| NEC | Naval Enlisted Classification |
| OC | Obstetrical Complications |
| OEF | Operation Enduring Freedom |
| OIF | Operation Iraqi Freedom |
| PE | Prolonged Exposure |

| | |
|---|---|
| PTSD | Post-Traumatic Stress Disorder |
| SADR | Standard Ambulatory Data Record |
| SIDR | Standard Inpatient Data Record |
| SSRI | Selective Serotonin Reuptake Inhibitor |
| TEDI | TRICARE Encounter Data–Institutional |
| TEDN | TRICARE Encounter Data–Non-Institutional |

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# I. INTRODUCTION

## A. PURPOSE

The United States (U.S.) armed forces have been involved in the Global War on Terrorism (GWOT) for over ten years. The GWOT includes ground combat operations in Operation Enduring Freedom (OEF) in Afghanistan, and Operation Iraqi Freedom (OIF) in Iraq. More than 2.3 million U.S. military service members have been deployed to Iraq or Afghanistan or both since 2001 (Martinez, 2011). With the prolonged operations, the total number of military personnel deployed overseas has increased over the years. To meet the personnel demands of sustained operations, more service members have been sent on more frequent and longer deployments.

During these military operations, many U.S. military personnel experienced prolonged psychological stress and combat-related situations. A large number of personnel also directly experienced blasts from improvised explosive devices (IED) or on the battlefield, or they indirectly experienced combat stress through seeing or helping dead and injured friends. These war-related risks and stressors have led to higher prevalence rates of mental health conditions, such as Post-Traumatic Stress Disorder (PTSD), major depression and substance use disorders (Shen, Arkes, & Williams, 2012; Tanielian & Jaycox, 2008).

Current studies have suggested that 10% to 18% of troops deployed to OEF or OIF are suffering from PTSD, a mental health disorder resulting from experiencing or witnessing traumatic or life-threatening events (Litz & Schlenger, 2009). With the increased tempo of OEF and OIF between FY2003 and 2006, the number of PTSD cases among deployed personnel grew at an increasing rate across all services (Kwan & Tan, 2008). Other than PTSD, the majority of the studies have centered on mental health conditions, such as major depression

and substance use. There is little research done on other costly mental health conditions, such as schizophrenia and bipolar disorder among the OEF/OIF veterans.

U.S. troops were fully withdrawn from Iraq by December 2011. The number of troops in Afghanistan is declining as part of the plan for withdrawal by 2014 (White House, 2011, 2012). However, given the chronic nature associated with many mental health conditions, the mental health care needs of the returned service members will still be present long after the end of the combat operations. This study will use 10 years of data on all active duty service members, and examine the incidence of three mental health conditions (PTSD, schizophrenia and bipolar disorder) across the different branches of the U.S. military. This study will also look at how deployment, service, and demographic characteristics affected the probability of these mental health conditions during the GWOT era.

## B. RESEARCH QUESTIONS

This thesis is an extension of a study by Shen, Arkes, Kwan, and Tan (2010). In that study, the authors examined the association of deployment and PTSD of active duty service members between FY2001 and FY2006 across all four branches of the U.S. armed services. Service members who have been deployed overseas were found to have higher PTSD prevalence rates.

From FY2006 to FY2010, the U.S. military's war efforts stepped up. The number of boots on the ground increased to over 170,000 in Iraq in end 2007 and over 90,000 in Afghanistan at the close of 2010 (U.S. Library of Congress, 2011). With the increased number of deployments from FY2006 to FY2010, this study will provide more updated information on the relationship between deployment and PTSD. This study will also examine if there is an association between deployment and schizophrenia or bipolar disorder. These will be examined through the following research questions:

- What is the probability of being diagnosed with PTSD, schizophrenia, or bipolar disorder across different branches of the U.S. military since the start of the Global War on Terrorism (GWOT)?
- How do risk factors including being deployed and deployment characteristics (such as deployment location, frequency of deployment, and duration) affect the probability of being diagnosed with PTSD, schizophrenia, or bipolar disorder?
- Is there a spike in the incidence of PTSD, schizophrenia, or bipolar disorder after the surge in number of military personnel deployed since CY2006?
- Do the effects, if any, differ between male and female and between those in direct combat and those in other military specialty jobs?

In this thesis, all active duty service members between FY2001 and FY2011 will be analyzed. Separate analyses will be conducted for each mental disorder, and for each branch of armed services (Army, Navy, Marine Corps and Air Force). Separate analyses for enlisted personnel and officers within each branch will also be conducted.

## C. STUDY OVERVIEW AND SIGNIFICANCE

This thesis uses both descriptive statistics and multivariate analysis methods to study if deployment, service and demographic characteristics affect the probability of PTSD, schizophrenia and bipolar disorder among U.S. military service members.

First, this thesis will provide a literature review of research on PTSD, schizophrenia and bipolar disorder. The review will focus on past studies on the effect of military deployment on PTSD, especially during OEF and OIF. It will also focus on how deployment-related situations could have an effect on schizophrenia and bipolar disorder.

Second, this thesis will provide multivariate analyses that address the four research questions stated above. Demographic, medical and deployment data from the Defense Manpower Data Center (DMDC) and TRICARE between FY2001 and FY2011 will be merged.

## D. ORGANIZATION OF STUDY

This thesis is organized as follows: Chapter I provides the background on deployments for the GWOT and a brief summary of the association between PTSD and GWOT. Chapter II provides a summary of prevailing research on PTSD, schizophrenia and bipolar disorder. Chapter III describes the data sources and categories. Chapter IV describes the analytical methodology of both descriptive statistics and multivariate analysis models. Chapter V presents the descriptive analysis results regarding service, demographic and deployment characteristics of the population. It also includes the prevalence rates of PTSD, schizophrenia and bipolar disorder across different deployment characteristics of the four services of the U.S. military. Chapter VI presents the probit analysis of the effects of deployment characteristics, service characteristics and demographic characteristics on the probability of being diagnosed with PTSD and bipolar disorder. Chapter VII presents the conclusions, study limitations and recommendations.

# II. LITERATURE REVIEW

## A. INTRODUCTION

Since the beginning of hostilities in Afghanistan in October 2001, more than 1.8 million U.S. troops have served in Operation Enduring Freedom (OEF) in Afghanistan or Operation Iraqi Freedom (OIF) in Iraq, with at least 37% having deployed at least twice (Litz & Schlenger, 2009). Studies have shown that 36% of soldiers who have returned home from the Global War on Terrorism (GWOT) have sought treatment for mental health issues (Bilmes, 2007). These soldiers are those who have fought on the ground in Iraq or Afghanistan, and adjacent locations (for instance, Kuwait, which is an important staging post for Iraq). Among those who had sought treatment, Post-Traumatic Stress Disorder (PTSD) has been a leading mental health condition among military personnel and veterans who had served in Iraq and Afghanistan, with heavy combat typically cited as a leading cause of PTSD.

Studies to date suggest that 10–18% of the combat troops serving in OEF/OIF have probable PTSD following deployment, and the prevalence does not diminish over time (Litz & Schlenger, 2009). There are, however, few statistics on bipolar disorder and schizophrenia among the OEF/OIF veterans. With the last U.S. troops having left Iraq at the end of 2011 and the projection of all troops to leave Afghanistan by 2014, it is thus timely to conduct a ten-year look back at the association between the Global War on Terrorism (GWOT) and these three costly mental health conditions.

This chapter provides an overview of prevailing studies on PTSD, bipolar disorder and schizophrenia symptoms and their treatment costs. Section B defines the clinical definition, symptoms and treatment of PTSD, followed by past research on PTSD in Section C, which examines the prevalence and risk factors of PTSD. Similar-styled discussions are conducted for bipolar disorder and

schizophrenia from Section D to G. Section H discusses the shortcomings in prevailing studies while Section I summarizes and concludes the chapter.

## B. DEFINITION OF PTSD, SYMPTOMS AND TREATMENT

PTSD is the psychiatric disorder that can result from the experience or witnessing of traumatic or life threatening events such as terrorist attack, violent crime and abuse, military combat, natural disasters, serious accidents or violent personal assaults (Iribarren, Prolo, Neagos, & Chiappelli, 2005). The dysphoria factor of PTSD symptoms includes symptoms that overlap with many disorders such as feelings of isolation, loss of interest in activities, irritability, and sleep disturbance (Simms, Watson, & Doebbeling, 2002).

While it is normal for such events to trigger such an anxiety disorder, in the case of PTSD, this reaction is changed or damaged. People who have PTSD may feel stressed or frightened even when they are no longer in these events. These symptoms must persist for at least one month, and they must cause clinically significant distress and affect the individual's ability to function socially, occupationally, or domestically (Bisson, 2007). OEF/OIF veterans who screened positive for PTSD were found to be more than four times as likely to report suicidal ideation relative to non-PTSD veterans (Jakupcak & Varra, 2010). PTSD is also associated with reported reductions in quality of life, which includes general health, energy, emotional well-being, emotional role limitation, physical role limitation and social functioning (Erbes, Westermeyer, Engdahl, & Johnsen, 2007).

According to the *Diagnostic and Statistical Manual of Mental Disorders* 4th edition (*DSM IV-TR*) classification by American Psychiatric Association (APA; 2000), the person must also have experienced intense fear, helplessness, or horror when the event occurred. The characteristic symptoms of PTSD, adapted from *DSM IV-TR* are summarized in Table 1.

Table 1. Symptoms of PTSD as classified by *DSM IV-TR*

| **Re-experiencing phenomena (at least one required)** |
|---|
| • Recurrent and intrusive distressing collections<br>• Recurrent distressing dreams<br>• Acting or Feeling as if the events are recurring<br>• Intense psychological distress to cues<br>• Physiological reactivity to cues |
| **Avoidance and numbing (at least three required)** |
| • Avoidance of thoughts, feelings and conversations<br>• Avoidance of reminders<br>• Psychogenic amnesia<br>• Greatly reduced interest in related activities<br>• Detachment or estrangement feelings<br>• Restricted range of affect<br>• Sense of a foreshortened future |
| **Increased arousal (at least two required)** |
| • Difficulty sleeping<br>• Irritability or outbursts of anger<br>• Difficulty concentrating<br>• Hypervigilance<br>• Exaggerated startle response |

According to the National Institute of Mental Health (n.d.) and the U.S. Department of Veterans Affairs (2007), the main treatments for people with PTSD are psychotherapy, medications, or both, depending on individuals. Some people with PTSD need to try different treatments to find what works for their symptoms.

One method is Cognitive Behavioral Therapy (CBT), which is a blend of two therapies: Cognitive Processing Therapy (CPT) and Prolonged Exposure (PE) therapy. CPT is the process when the therapist helps the patient to

understand and change how he thinks about his trauma and its aftermath. In PE, the patient's goal is to have less fear about his memories. It is based on the idea that people learn to fear thoughts, feelings, and situations that remind them of a past traumatic event.

CBT has shown to be effective in treating mental health disorders, including PTSD (Butler, Chapman, Forman, & Beck, 2006; Harvey, Bryant, & Tarrier, 2003). Several studies have also shown CBT to be effective in reducing suicidal behaviors (Tarrier, Taylor, & Gooding, 2008).

Besides CBT, other treatment methods include eye movement desensitization and reprocessing (EMDR). Medications have also been shown to be effective. A type of drug known as a selective serotonin reuptake inhibitor (SSRI), which is also used for depression, is effective for PTSD.

The costs associated with PTSD can be of various forms. A study done by Rand Corporation listed the main cost outcomes of PTSD, which include treatment costs, the costs of lives lost to suicide, and costs related to lost productivity (including reduced employment and lower earnings) (Tanielian & Jaycox, 2008). There are also secondary costs to PTSD such as costs stemming from family stress and caregiver burden. The study used a microsimulation model to predict that two-year costs resulting from PTSD (and major depression) for the approximately 1.6 million service members who have deployed since 2001 could range from $4.0 to $6.2 billion. These costs are taken in societal perspective and accrue to all members of U.S. society, which potentially include government agencies, service members, their families, employers, private health insurers, taxpayers, and others. The study also approximated the average treatment cost per case over two years for all returning service members with PTSD to be $10,298 (for cases with suicide mortality) and $5,904 (for cases without suicide mortality).

## C. PAST RESEARCH ON PTSD

Past literature covered extensively the relationship of deployment in combat zones and the risk of development of PTSD. Shen et al. (2010) had found that deployment to Iraq/Afghanistan increases the odds of developing PTSD substantially, with the largest effect for the Navy and the smallest effect for the Air Force. The tour length also matters, as a deployment lasting longer than 180 days increases the odds of PTSD by 1.11 to 2.84 times, depending on the service, as compared to a short tour of less than 180 days. In their study, they also found that females are significantly more likely to be diagnosed with PTSD across all services, with odds ratio ranging from 2.96 to 6.34. In terms of Military Occupational Specialty (MOS), service members in combat arms are more likely to be diagnosed with PTSD than non-combat arms service members across all service branches.

Vasterling et al. (2010) also found that military deployment to Iraq is associated with pre- to post-deployment increases in PTSD symptoms, from 11% to 29%. Non-deployed soldiers, on the other hand, did not show symptom increases, suggesting that pre- to post-deployment increases could not be attributed to nonspecific factors inherent to military life.

Brown, Antonius, Kramer, Root, and Hirst (2010) also found that trauma centrality, which is the extent to which an individual integrates a traumatic event into their identity, and PTSD severity are positively correlated (0.58).

Exposure to a combat situation was also found to be correlated with screening positive for PTSD among OIF veterans. OIF and OEF veterans also used inpatient and outpatient mental health services at a higher rate after deployment than service members who deployed to other locations (Hoge, Auchterlonie, & Milliken, 2006). Overall, prevalence of scoring two or more in the four-item primary-care PTSD scale were 9.8% for OIF, 4.7% for OEF and 2.1% for other locations. Their findings showed that there is a higher occurrence in mental health disorders deployment in OIF, followed by OEF, with deployment in

other locations having the least occurrence. They also found that those who screened positive for a mental health concern were significantly more likely to leave service for any reason during the year after deployment than those who screened negative for all deployment locations, including Iraq and Afghanistan (21.4% vs 16.4%).

A study on the relationship between physical injury and PTSD was also conducted by MacGregor et al. (2009). They found that compared with non-battle injuries, those with battle injuries had a greater risk of PTSD. Those with minor injuries (odds ratio 2.63), moderate injuries (odds ratio 4.01), serious injuries (odds ratio 8.69) and severe injuries (odds ratio 8.88) were more likely to receive diagnosis of PTSD.

Hoge and colleagues (2004) conducted a study that showed that exposure to combat was significantly greater among those who were deployed to Iraq than among those deployed to Afghanistan. The percentage of study subjects whose responses met the screening criteria for major depression, generalized anxiety or PTSD was significantly higher after duty in Iraq (15.6% to 17.1%) than after duty in Afghanistan (11.2%) or before deployment to Iraq (9.3%); the largest difference was in the rate in PTSD.

Among Marine Corps personnel deployed to Iraq or Kuwait between January 2003 and December 2007, the rate of PTSD was higher among those with two deployments compared to one deployment (2.1% versus 1.2%) (MacGregor, Han, Dougherty, & Galameau, 2012).

## D. DEFINITION OF SCHIZOPHRENIA, SYMPTOMS AND TREATMENT

Schizophrenia is a chronic psychological disorder that affects approximately 1.1% among those of age 18 and older in a given year (Regier et al., 1993). Symptoms can be broadly grouped into “positive” and “negative” symptoms. The positive symptoms involve an excess of ideas, sensory, experiences, or behavior, such as hallucinations, delusions, and bizarre

behaviors. Negative symptoms involve a decreased reactivity to the environment, such as blunted or flat affect (reduction in emotional expression), anhedonia (absence of positive emotions in normally pleasurable situations), lesser speech, and lack of motivation (Harvey & Walker, 1987). Based on the *DSM IV* classification, the person must have signs and symptoms of the disorder present for six months or more (including prodromal and residual phases), and cause social/occupational dysfunction. Significant mood disorder, such as depression or manic symptoms, general medical conditions or substance abuse that might lead to psychotic symptoms must not be present (APA, 2000). The characteristic symptoms of schizophrenia (adapted from *DSM IV-TR*) are summarized in Table 2.

Table 2. Symptoms of schizophrenia as classified by *DSM IV-TR*

| **Characteristic symptoms (at least two or more required for at least one month)** |
|---|
| • Hallucinations<br>• Delusions<br>• Disorganized speech (e.g., frequent derailment or incoherence)<br>• Grossly disorganized or catatonic behavior<br>• Negative symptoms, i.e., affective flattening, alogia, or avolition |
| **Additional symptoms (only one characteristic symptom required if an additional symptom exists)** |
| • Bizarre delusions<br>• Hallucinated voices consist of a running commentary or of two voices conversing |

There are four subtypes of schizophrenia, namely paranoid, catatonic, disorganized, and undifferentiated. The paranoid subtype is preoccupied with delusions or hallucination, but there is no disorganized speech, disorganized or catatonic behavior, or flat or inappropriate affect. The catatonic subtype involves a clinical syndrome that is dominated by postural and/or movement

abnormalities, mutism, or echolalia. As for the disorganized subtype, all of the following symptoms are prominent: disorganized speech, disorganized behavior, and flat or inappropriate affect, but the criteria for the catatonic subtype are not met. The undifferentiated subtype is diagnosed when the patient does not meet criteria for the previous subtypes, but does meet the general criteria for schizophrenia (APA, 2000).

Many studies have tried to determine the causes of schizophrenia. One of the findings is that the vulnerability to schizophrenia can be inherited. The risk for schizophrenia increases in individuals who have a biological relative with the disorder, and the likelihood increases if the level of genetic relatedness is closer (Gottesman, 1991). Findings from an adoption study by Tiernari, Wynne, Moring and Lahti (1994) show that genetic influences as well as environmental factors play a part. Genetic vulnerability was mainly expressed in association with disruptive adoptive environments, but the increased rate of schizophrenia was not detected in adoptees reared in healthy family environments.

Studies showed that schizophrenia patients are more likely to have a history of obstetrical complications (OCs) (Dalman, Allebeck, Cullberg, Grunewald, & Koester, 1999; McNeil, Cantor-Graae, & Weinberger, 2000). Stressful events during pregnancy are also associated with greater risk for schizophrenia and other psychiatric disorders in adult offspring (Huttunen, 1989). One explanation is that prenatal stress triggers the release of maternal stress hormones which disturbs fetal neurodevelopment which influences behavior and cognition (Welberg & Seckl, 2001).

Post-natal events can also play a part. Individuals who sustain head injuries are also shown to have heightened risk for a variety of psychiatric disorders, including schizophrenia. The association is stronger if the injuries occurred in early childhood (AbdelMalik, Husted, Chow, & Bassett, 2003). Research also shows that stressful events play a part. Preceding a schizophrenia relapse, the number of stressful life events has been found to increase (Ventura,

Nuechterlein, Hardesty, & Gitlin, 1992). Indirect evidence also indicates that stress can induce the onset of schizophrenia symptoms in vulnerable individuals. Children of biological mothers with schizophrenia are at greater risk for the disorder if their adoptive families are dysfunctional (Tienari et al., 1994).

There are various treatments available for schizophrenia. Antipsychotic medications reduce dopamine activity. The commonly prescribed atypical antipsychotics in the United States include Risperdal (risperidone), Zyprexa (olanzapine), Seroquel (quetiapine), and Geodon (ziprasidone). Psychosocial treatment methods include family therapy which has shown to improve family members' coping and knowledge about schizophrenia, which then reduces the risk of relapse. Cognitive behavior therapy (CBT) helps psychotic patients deal directly with their symptoms. It has shown to be effective in reducing hallucinations and delusions in medication-resistant patients, and can be a complement to medication (Walker, Kestler, Bollini, & Hochman, 2004). Stress management has also been shown to benefit individuals with schizophrenia. An explanation is that stress management training provides individuals with skills to cope with stressors effectively and reduces the intensity of symptoms (Norman et al., 2002).

Schizophrenia can be very costly in terms of treatment costs and indirect costs. Indirect costs include loss of earnings due to unemployment of the patient, as well as loss of earnings for the patient's family. In the United States, the in-patient hospitalization cost for first-episode cases in 1986 was $2.3 billion (in 1993 dollars) and $2 billion for relapses cases annually (Weiden & Olfson, 1995). Indirect costs have been estimated to be one to four times higher than the direct costs. Suicide rates among schizophrenia patients are more than twice those of the general population (Knapp, 1997). In the UK, the lifetime cost (direct and indirect) ranges from £1,700 to £316,000 per person (equivalent to $2,700 to $506,000) (Davies & Drummond, 1994).

## E. PAST RESEARCH ON SCHIZOPHRENIA

The literature on gender difference in risk of schizophrenia is not consistent. Kennedy et al. (2002) found that schizophrenia is more prevalent among males, while Hendrick, Altshuler, Gitlin, Delrahm, and Hammen (2000) found that the lifetime risk is the same for males and females. Häfner (2003) also reported similar lifetime risks for males and females, but the onset of schizophrenia is earlier for males in the early twenties to mid-thirties, while more females were diagnosed with schizophrenia after their mid-thirties.

Schizophrenia has been identified as one of the comorbid psychiatric disorders in PTSD, but the prevalence rate differs among studies. Escobar et al. (1983) found that 35% of Hispanic veterans with PTSD had comorbid diagnosis of schizophrenia (Escobar et al., 1983). Among patients with severe mental illness, PTSD prevalence was reported at 28% among patients with schizophrenia, which is higher than the lifetime prevalence of the general population. However, the prevalence rate is considered low compared to other mental illness, such as depression and borderline personality disorder (Mueser et al., 1998). Resnick, Bond, and Mueser (2003) reported a lower PTSD prevalence rate of 12.8% among people with schizophrenia.

## F. DEFINITION OF BIPOLAR DISORDER, SYMPTOMS AND TREATMENT

Bipolar disorder, otherwise known as manic-depressive disorder, is characterized by dramatic mood swings. Bipolar disorder can be mainly classified into Bipolar I disorder and Bipolar II disorder.

Based on the DSM-IV classification on Bipolar I disorder, the individual must have at least one episode of a manic or mixed episode. There may be episodes of hypomania or major depression as well. As for Bipolar II disorder, the individual diagnosed with Bipolar II disorder must have at least one episode of

hypomania and an episode of major depression. The symptoms must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Genetics has shown to be a strong determinant of bipolar disorder. Lichtenstein et al. (2009) found that first-degree relatives of individuals with bipolar disorder had increased risk. Adopted children with biological parents who had bipolar disorder had a more than four-fold risk of bipolar disorder. Environmental stressors also seem to play a part. Goldberg & Garno (2005) found that 51% of a cohort of 100 adults with bipolar disorder had a history of severe trauma. Bebbington et al. (1993) also found that higher rates of severe, independent stressors in the 6 months before onset were evident in hospitalized manic patients as compared to members of a normal control group.

There are several treatment methods for bipolar disorder. Pharmacotherapy is one of the most common methods. Medications range from mood stabilizers (lithium or anticonvulsants), antipsychotics (typical antipsychotics or atypical antipsychotics), antidepressants, and other medications (Möller & Nasrallah, 2003). Psychotherapy is also found to be useful. Cognitive behavioral therapy has been found to be effective in lowering the relapse of depression (Fava et al., 2004). Bipolar patients with family-focused treatment (FFT) had lower relapse rate over a 12-month period than bipolar patients in a comparison treatment involving two family education sessions and follow-up crisis management (Miklowitz et al., 2000).

Treatment costs of bipolar disorder can be significant for the U.S. military. In general, about two-thirds of bipolar disorder patients have been found to suffer at least one relapse requiring hospital admission. Among bipolar disorder patients, the mortality rate is two to three times greater than non-patients (Silverstone & Romans-Clarkson, 1989). In the U.S. military, affective disorder (ICD-9 code: 296), including bipolar disorder, has been found to be the third most common reason for hospitalization of military personnel. In FY2001, the

Department of Veterans Affairs spent over $3 billion for psychiatric care of patients with psychosis or bipolar disorder (Sajatovic, Blow, & Ignacio, 2004). The social cost of bipolar disorder is also high. Bipolar disorder patients were also found to function less well at work than non-patients. The proportion of bipolar disorder population employed or studying full-time was significantly lower than those without bipolar disorder (Shippee et al., 2011). This means that bipolar disorder is related to lost work productivity.

Overall, the total annual societal cost of bipolar disorder was approximately £6,919 per person (equivalent to $12,000 at 1999/2000 prices) with bipolar disorder in the UKs. This includes treatment and hospitalization costs, as well as indirect societal costs such as unemployment, absenteeism from work and suicide (Gupta & Guest, 2002). In the United States, the present value lifetime cost (both direct and indirect) per person with bipolar disorder in 1998 dollars was estimated to be from $11,720 to $624,785 (Begley et al., 2001).

## G. PAST RESEARCH ON BIPOLAR DISORDER

In the U.S. military, Weber, Cowan, Bedno, and Niebuhr (2010) looked at all hospitalized military personnel (active duty and reserve component in 1997 to 2006). They found that the incidence rate of bipolar I disorder was 0.21 for men, and higher, at 0.40, for women. The incidence rate of bipolar I disorder was higher among whites than blacks, except the manic type. There is a significant decrease in the incidence rate with age among men, black and white, and among white women. Similarly, Krishkan (2005), Kennedy et al. (2002) and Shippee et al. (2011) found that bipolar disorder is more prevalent among females.

Bipolar disorder has been found to be a comorbid condition with PTSD. PTSD prevalence among bipolar disorder patients was at 40%, which was the third highest among patients with severe mental illness, following depression (58%) and borderline personality disorder (54%) (Mueser et al., 1998).

## H. SHORTCOMINGS IN PREVAILING STUDIES

One of the shortcomings in prevailing studies on the relationship between the military and psychosis is the limited number of studies conducted on schizophrenia and bipolar disorder. While there are many studies that are able to draw conclusions that the prevalence of PTSD increases over time and the exposure to combat situations and probability of developing PTSD are positively related, there are limited similar studies conducted to test on the relationship between number of deployments, length of deployment and exposure to combat situations, and schizophrenia and bipolar disorder.

The other shortcoming is the quality of the data used. Most data used are either of a small sample size, a short duration or specific combat troops. This may lead to selection bias and thus provides inaccurate estimates.

Some studies used surveys to determine the symptoms of PTSD, schizophrenia or bipolar disorder. The results may not be accurate as well, as respondents may not divulge true or personal information. Such surveys may also not be medically robust to correctly determine if an individual is indeed suffering from these three mental health disorders.

Shen et al. (2010) did a similar study on the effect of deployment and the probability of being diagnosed with PTSD across all four services of the U.S. armed services. In defining deployment, the study looked at the effects of the last deployment. However, this might lead in bias as the last deployment may be biased toward the outcome (diagnosis of PTSD) that is being studied.

## I. SUMMARY

Although there are many studies that find a positive relationship between the probability of developing PTSD and combat exposure, especially in OEF and OIF, there are a limited number of similar studies on schizophrenia and bipolar disorder. There are also few studies that used data from the entire DoD population, due to the sensitivity and security of the data. Nor are there many

studies that use data that stretch for a long duration of up to ten years. There are also limited studies that directly compare the possibility of developing PTSD, schizophrenia and bipolar disorder across the four different services.

With these shortcomings and with GWOT coming to a close, there is a need to conduct a study on the possible mental health conditions for the troops returning from Iraq and Afghanistan. The results of this study will be able to accurately estimate the prevalence of the different health conditions across the various services. The implications for the DoD will be to ensure sufficient health care services are available, determine the costs of treatment, prepare for possible attrition after deployment, and improve the overall readiness of the U.S. armed services.

# III. DATA CATEGORIES AND SOURCES

## A. INTRODUCTION

This chapter discusses the data sources and categories of data used for this thesis. Section B describes the data sources. Section C describes the categories of data used. Section D identifies and describes the data limitations. Section E provides a summary of the chapter.

## B. DATA SOURCES

There are generally two main sources, TRICARE and Defense Manpower Data Center (DMDC). These two sources provide three key categories of data: basic demographic information, mental health disorders diagnosis information and deployment information.

This thesis uses manpower data from FY2001 to FY2011. There are four sets of demographic data from TRICARE, one from each service. TRICARE also provided two inpatient and two outpatient mental health disorder diagnosis data. These data contain the type of mental health disorder and the date of diagnosis for each service member. DMDC provided deployment data and the Military Occupational Specialty (MOS) information for every service member. The datasets used and their sources are summarized in Table 3.

Table 3. Summary of datasets used and their sources

| Datasets | Source |
|---|---|
| 1 set of Army demographic data<br>1 set of Marine Corps demographic data<br>1 set of Navy demographic data<br>1 set of Air Force demographic data | TRICARE |
| 2 sets of inpatient mental health disorders diagnosis data<br>2 sets of outpatient mental health disorders diagnosis data | TRICARE |
| 1 set of deployment data<br>1 set of Military Occupational Specialty (MOS) data | DMDC |

### 1. TRICARE

TRICARE is the health care program serving U.S. military active duty service members, National Guard and Reserve members, retirees, their families, survivors and certain former spouses worldwide. As a major component of the Military Health System (MHS), TRICARE brings together the health care resources of the uniformed services and supplements them with networks of civilian health care professionals, institutions, pharmacies and suppliers to provide access to high-quality health care services while maintaining the capability to support military operations (TRICARE, 2012). Currently, TRICARE serves approximately 9.7 million beneficiaries worldwide.

The data from TRICARE provided two of the three key categories of information as mentioned above. TRICARE's Defense Enrollment Eligibility Reporting System (DEERS) provided the basic demographic information. The MHS provided the mental health disorders diagnosis information, which included Post-Traumatic Stress Disorder (PTSD), schizophrenia and bipolar disorder.

### 2. Defense Manpower Data Center (DMDC)

Defense Manpower Data Center (DMDC) is the Department of Defense's (DoD) human resource information source. It currently serves as the authoritative source of information on over 42 million people now and previously connected to DoD. It provides secure services and solutions to support DoD's mission, and is recognized as a world leader in identity management (DMDC, n.d.). The third category of information, deployment information, is obtained from DMDC's Contingency Tracking System (CTS). CTS began tracking deployment information under Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) missions in FY2001. It contains data on deployment characteristics for all active duty service personnel from the U.S. military who were deployed between FY2001 and FY2011.

## C. DATA CATEGORIES

For this thesis, the data are categorized into three key categories, namely, basic demographic information, mental health disorders diagnosis information and deployment information.

### 1. Basic Demographic Information

As mentioned earlier, DEERS is a worldwide, computerized database of uniformed services members (sponsors), their family members, and others who are eligible for military benefits, including TRICARE (TRICARE, 2011). All service members are automatically registered in DEERS, thus it captures all basic demographic information of active duty service members.

To provide confidentiality of the members, each service member is represented by a unique number called an Electronic Data Interchange Person Number (EDIPN). No names, social security numbers or any other personal information are given that would allow researchers to identify specific individuals. EDIPN is also the key to link every member across various data sources to obtain mental disorder diagnosis information and deployment information.

Key demographic variables that can be obtained from DEERS include gender, race, branch of service, marital status, pay grade, age and MOS.

The entire DEERS data set consists of 2,800,999 unique EDIPN observations of active duty service members from all four services who had served from FY2001 to FY2011.

### 2. Mental Health Disorders Diagnosis Information

Mental health disorders diagnosis information is obtained from TRICARE's inpatient and outpatient records, which contain four different data files: Standard Inpatient Data Record (SIDR), TRICARE Encounter Data—Institutional (TEDI), Standard Ambulatory Data Record (SADR)/Comprehensive

Ambulatory/Professional Encounter Record (CAPER), and TRICARE Encounter Data—Non-Institutional (TEDN).

SIDR and TEDI data files contain all medical treatment records among personnel with mental disorders who were admitted under the inpatient setting. SADR/CAPER and TEDN data files contain all treatment patterns among personnel with mental disorders who were admitted under the outpatient setting.

### *a. Inpatient Records of Mental Health Disorder*

As long as a service member is eligible for TRICARE, he is entitled to use the health care services in the Military Treatment Facilities (MTFs). MTFs are usually located on or near military bases and are facilities where TRICARE beneficiaries may receive care. As defined by the TRICARE Operations Manual (2008), inpatient care refers to care provided to a patient who has been admitted to a hospital or other authorized institution for bed occupancy for purposes of receiving necessary medical care, with the reasonable expectation that the patient will remain in the institution at least 24 hours, and with the registration and assignment of an inpatient number or designation.

Under the DoD's MHS, active duty service members' treatment information is captured in the SIDR database. This happens as long as they seek medical inpatient care from MTFs and they are eligible for TRICARE. For active duty service members who are eligible for TRICARE but seek medical inpatient care from a hospital or other authorized institutional provider, their treatment information is captured in the TEDI database once they are given inpatient care for at least 24 hours with a registration and assignment of an inpatient number or designation.

(1) Standard Inpatient Data Record (SIDR)

Out of the entire population of 2,800,999 service members, 5,236 of them sought inpatient treatment in MTFs. Among them, 2,921 service members sought treatment for PTSD, 721 for schizophrenia and 1,594 for bipolar disorder.

(2) TRICARE Encounter Data–Institutional (TEDI)

Out of the population, 5,885 service members sought inpatient treatment in a hospital or other authorized institutional provider. 3,625 sought treatment for PTSD, 342 for schizophrenia and 1,918 for bipolar disorder.

***b. Outpatient Records of Mental Health Disorder***

Service members who are eligible for TRICARE are also entitled to specialized/professional medical services or outpatient treatment in both MTFs and hospitals or other authorized institutional providers. Outpatient observation stays are those services furnished by a hospital on a hospital's premises, including the use of a bed and periodic monitoring by a hospital's nursing or other staff, which are reasonable and necessary to evaluate an outpatient's condition or determine whether there is a need for a possible admission to the hospital as an inpatient. Such services are provided when ordered by a physician or other individual authorized by State licensure law and hospital staff bylaws to admit patients to the hospital or to order outpatient tests.

Under the DoD's Military Health System (MHS), active duty service members' treatment information is captured in the SADR/CAPER database as long as they seek medical outpatient care from MTFs and they are eligible for TRICARE. SADR provided the outpatient information from FY2001 to FY2006. From FY2007 to FY2011, the SADR system was replaced by CAPER.

For active duty service members who are eligible for TRICARE but seek specialized/professional medical services or outpatient treatment from a hospital or other authorized institutional provider, treatment information is

captured in the TEDN database. In this case, a TEDN record reflects either inpatient or outpatient health care services exclusive of inpatient institutional facility services.

(1) Standard Ambulatory Data Record (SADR)/ Comprehensive Ambulatory/Professional Encounter Record (CAPER)

Out of the population, 115,324 service members sought specialized/professional medical services or outpatient treatment in MTFs. This posted the highest source of diagnosis of mental disorders. Of those service members, 92,799 sought treatment for PTSD, 3,347 for schizophrenia and 19,178 for bipolar disorder.

(2) TRICARE Encounter Data–Non-Institutional (TEDN)

Out of the population, 20,688 service members sought specialized/professional medical services or outpatient treatment in a hospital or other authorized institutional provider. More specifically, 14,208 sought treatment for PTSD, 860 for schizophrenia, and 5,620 for bipolar disorder.

### *c. Trend of Records of Mental Health Disorder*

Tables 4 and 5 show the overall breakdown of mental health disorder treatment in both inpatient and outpatient facilities for PTSD, schizophrenia and bipolar from CY2000 to CY2011, for active duty enlisted personnel and officers respectively.

Using the full-year equivalent number of active duty enlisted personnel as the base, the percentages of enlisted personnel diagnosed with PTSD, schizophrenia and bipolar disorder in each year can be observed. The same can be observed for the officers.

An upward trend in the number of new PTSD cases over the years can be observed in both the enlisted and officer population. There is also an upward trend in the number of new bipolar disorder cases in the enlisted population. From CY2006 onward, there is a surge in the number of new cases

of PTSD and bipolar disorder. The most distinctive increase was in CY2007, where the number of new PTSD cases among enlisted personnel increased by 1.5 times. This coincides with the period in which the U.S. military had stepped up its war efforts, as mentioned in Chapter I. There is no noticeable trend for new cases of schizophrenia.

Table 4. Active duty enlisted personnel diagnosed with PTSD, schizophrenia and bipolar disorder in a hospital or other authorized institutional provider

| Year | PTSD | | Schizophrenia | | Bipolar Disorder | | Full Year Equivalent Number of Active Duty Enlisted Personnel[#] |
|---|---|---|---|---|---|---|---|
| | Number | % of active duty during the year | Number | % of active duty during the year | Number | % of active duty during the year | |
| CY2000* | 722 | 0.27% | 213 | 0.078% | 429 | 0.16% | 271,508 |
| CY2001 | 2,218 | 0.19% | 649 | 0.055% | 1,663 | 0.14% | 1,180,359 |
| CY2002 | 2,189 | 0.17% | 491 | 0.038% | 1,999 | 0.16% | 1,276,907 |
| CY2003 | 2,951 | 0.22% | 480 | 0.036% | 2,359 | 0.18% | 1,332,065 |
| CY2004 | 5,806 | 0.44% | 454 | 0.034% | 2,173 | 0.16% | 1,332,940 |
| CY2005 | 9,251 | 0.71% | 469 | 0.036% | 2,398 | 0.18% | 1,302,769 |
| CY2006 | 9,639 | 0.75% | 446 | 0.035% | 2,978 | 0.23% | 1,287,350 |
| CY2007 | 14,466 | 1.13% | 494 | 0.039% | 3,032 | 0.24% | 1,276,381 |
| CY2008 | 17,519 | 1.51% | 464 | 0.040% | 3,153 | 0.27% | 1,162,124 |
| CY2009 | 16,258 | 1.61% | 373 | 0.037% | 2,696 | 0.27% | 1,009,707 |
| CY2010 | 15,140 | 1.76% | 314 | 0.037% | 2,211 | 0.26% | 859,993 |
| CY2011* | 10,838 | 1.97% | 184 | 0.033% | 1,374 | 0.25% | 550,292 |

* The number of active duty service members in 2000 and 2011 is lower because the DEERS data only captures the last quarter in CY2000 and the first three quarters in CY2011.

[#] The full year equivalent number of active duty service members refers to the number of weighted service members. The weightage is computed based on the number of months of service in the particular year. For example, 12 months of service is equivalent to one service member, whereas 3 months of service is equivalent to 0.25 service member.

Table 5. Active duty officers diagnosed with PTSD, schizophrenia and bipolar disorder in a hospital or other authorized institutional provider

| Year | PTSD | | Schizophrenia | | Bipolar Disorder | | Full Year Equivalent Number of Active Duty Officers[#] |
|---|---|---|---|---|---|---|---|
| | Number | % of active duty during the year | Number | % of active duty during the year | Number | % of active duty during the year | |
| CY2000* | 64 | 0.12% | 13 | 0.024% | 63 | 0.12% | 54,377 |
| CY2001 | 136 | 0.06% | 37 | 0.016% | 159 | 0.07% | 224,958 |
| CY2002 | 164 | 0.07% | 27 | 0.012% | 157 | 0.07% | 233,359 |
| CY2003 | 201 | 0.08% | 34 | 0.014% | 200 | 0.08% | 241,718 |
| CY2004 | 370 | 0.15% | 21 | 0.009% | 174 | 0.07% | 239,635 |
| CY2005 | 504 | 0.21% | 19 | 0.008% | 182 | 0.08% | 234,997 |
| CY2006 | 601 | 0.26% | 17 | 0.007% | 188 | 0.08% | 227,541 |
| CY2007 | 790 | 0.36% | 15 | 0.007% | 183 | 0.08% | 218,300 |
| CY2008 | 959 | 0.47% | 14 | 0.007% | 155 | 0.08% | 203,663 |
| CY2009 | 984 | 0.52% | 13 | 0.007% | 161 | 0.09% | 188,523 |
| CY2010 | 1,039 | 0.60% | 19 | 0.011% | 125 | 0.07% | 173,924 |
| CY2011* | 744 | 0.62% | 10 | 0.008% | 98 | 0.08% | 120,220 |

* The number of active duty service members in 2000 and 2011 is lower because the DEERS data only captures the last quarter in CY2000 and the first three quarters in CY2011.

[#] The full year equivalent number of active duty service members refers to the number of weighted service members. The weightage is computed based on the number of months of service in the particular year. For example, 12 months of service is equivalent to one service member, whereas 3 months of service is equivalent to 0.25 service member.

### 3. Deployment Information

In this thesis, the focus is to study the relationship between the probability of being diagnosed with a mental disorder and deployment characteristics. The deployment characteristics include deployment location, frequency and duration from FY2001 to FY2011. Thus, in addition to demographic information and diagnosis information on mental health disorders, deployment information is critical to this thesis.

Deployment information in this thesis is obtained from DMDC's CTS. In the data, every service member's history of deployment for OIF/OEF missions since the end of FY2001 is recorded. Information like deployment location and duration for each deployment from FY2001 to FY2011 can be obtained. The service members' Military Occupation Specialty (MOS) is also provided in the data. This will help in predicting the level of risk and exposure to combat or stressful events during deployment.

Based on the CTS data, there are a total of 1,223,435 servicemen who were deployed overseas. Descriptive statistics on overseas deployment will be discussed in Chapter V.

## D. DATA LIMITATIONS

Unlike the previous study by Shen et al. (2010), data for all service members from all four services is available for this thesis. The completeness of the data means that this study can be conducted without any form of sampling. However, several restrictions must be taken into consideration.

First, the datasets have missing information. For instance, some observations (less than 1%) do not have EDIPN and are thus being dropped from the study. There are also about 1–2% of the population with deployment information appearing earlier than it first appeared in DEERS data, and which therefore are omitted for this thesis.

Second, there are data entry errors in some observations. For example, some service members have different gender and race records over the years. These data are cleaned by classifying them according to the highest number of occurrence in the data set.

Finally, the data are incomplete for service members who enlisted in CY2000 and before. Due to the nature of the data obtained, the service start date is only available for service members who enlisted in CY2001 and beyond. There is no service start date for those who enlisted in CY2000 and before. Thus for this thesis, the way the observation window is constructed for these two groups of service members will be different. The details on the construction of the observation window and how the above-mentioned limitations are dealt with will be discussed in detail in Chapter IV.

## E. SUMMARY

This chapter has described the sources of the data used in this thesis, namely TRICARE and DMDC. From TRICARE, the demographic information is obtained from DEERS while the mental disorder diagnosis information is obtained from SIDR, SADR, TEDI and TEDN. From DMDC, the deployment information is obtained from the CTS.

While managing the data set, some data has to be cleaned to overcome issues that are present in the data, which includes missing data and errors in data entry. Dropping missing observations may inevitably result in errors in the estimates. However, due to the small percentage of such restrictions, the significance of this impact should be minimal.

The next chapter will discuss the analytical methodology and elaborate upon the models of this study. Following that, the subsequent chapters will discuss the results with in-depth analysis.

# IV. ANALYTICAL METHODOLOGY

## A. INTRODUCTION

This chapter will describe the hypotheses and the analytical methodology used to examine the four research questions outlined in Chapter I. The research questions are:

- What is the probability of being diagnosed with Post-Traumatic Stress Disorder (PTSD), schizophrenia, or bipolar disorder across different branches of the U.S. military since the start of the Global War on Terrorism (GWOT)?
- How do risk factors (including being deployed in Operation Enduring Freedom (OEF)/Operation Iraqi Freedom (OIF) missions) and deployment characteristics (such as deployment location, frequency of deployment, and duration) affect the probability of being diagnosed with PTSD, schizophrenia, or bipolar disorder?
- Is there a spike in the incidence of PTSD, schizophrenia, or bipolar disorder after the surge in the number of military personnel deployed in OEF/OIF missions since CY2006?
- Do the effects, if any, differ between males and females and between those in direct combat and those in other military specialty jobs?

The rest of this chapter will be organized as follows: Section B will lay out the research hypotheses for the research questions. Sections C and D will describe the descriptive statistics and multivariate analysis methods used to analyze each research question. Section E will provide a summary.

## B. RESEARCH HYPOTHESES

The main objective is to analyze the effect of deployment characteristics (such as deployment location, frequency of deployment, and deployment duration) on the probability of being diagnosed with PTSD, schizophrenia, or bipolar disorder across the different branches of the U.S. military. The thesis will also analyze how the effects may vary based on service and demographic characteristics. Previous studies have examined the effect of deployment to Iraq

and/or Afghanistan on PTSD and found that exposure to combat situations is positively related to being diagnosed with PTSD (Shen et al., 2010). There have not been many studies examining the effect of deployment in OEF/OIF missions on schizophrenia and bipolar disorder. However, prior research has shown that environmental stressors increase the probability of schizophrenia and bipolar disorder (Ventura et al., 1992). PTSD and bipolar disorder are found to be more prevalent in females (Kennedy et al., 2002; Krishkan, 2005; Shen et al., 2010; Shippee et al., 2011). There may not be a gender difference in lifetime risk of schizophrenia, but the onset for males occurs earlier in their twenties (Häfner, 2003; Hendrick et al., 2000).

On the relationship between deployment characteristics and the probability of being diagnosed with PTSD, schizophrenia and/or bipolar disorder, the authors of this thesis hypothesize the following:

- Being deployed in OEF/OIF missions will increase the probability of being diagnosed with PTSD, schizophrenia and/or bipolar disorder for all branches of the U.S. military.
- The deployment location will have varying effects on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. Specifically, the authors hypothesize that personnel who have been deployed to Iraq and/or Afghanistan will have a higher probability of being diagnosed with PTSD, schizophrenia and bipolar disorder, compared to personnel deployed to other locations who might have less exposure to direct combat.
- As the number and duration of deployments to Iraq and/or Afghanistan increases, the probability of being diagnosed with PTSD, schizophrenia and/or bipolar disorder will increase for all branches of the U.S. military.
- The probability of being diagnosed with PTSD, schizophrenia and/or bipolar disorder is higher for service members whose first deployment in OEF/OIF missions is on or after CY2006, as compared to those whose first deployment in OEF/OIF missions is before CY2006. From Chapter III, an upward trend of new PTSD cases is observed from CY2006. This could imply that post-surge troops have a higher chance of witnessing combat/stressful events.

- Whether the effect of deployment in OEF/OIF missions on the probability of being diagnosed with PTSD, schizophrenia and/or bipolar disorder is stronger or weaker for those in the combat arms specialty category is an empirical question. On one hand, due to the job nature, service members in combat arms during deployments in OEF/OIF missions are more likely to be exposed to high-stress events and war trauma than deployed service members in non-combat arms. On the other hand, those who chose to work in a combat arms specialty fields might be better prepared mentally for combat situations than those who self-select themselves into specialty fields that are not generally involved in direct combat situations.
- Based on prior literature (Häfner, 2003; Hendrick et al., 2000; Kennedy et al., 2002; Krishkan, 2005; Shen et al., 2010; Shippee et al., 2011), the authors hypothesize that females have a higher probability of being diagnosed with PTSD and bipolar disorder, while males have a higher probability of being diagnosed with schizophrenia. The gender effect is magnified during deployment in OEF/OIF missions.

## C. PREVALENCE OF PTSD, SCHIZOPHRENIA AND BIPOLAR DISORDER IN THE ACTIVE DUTY U.S. ARMED SERVICES

This thesis first aims to examine the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder in the active duty U.S. armed services. As mentioned in Chapter III, linked data from the TRICARE and DMDC are used in this thesis. For the first research question, the authors will implement descriptive analysis to provide a summary of service and demographic characteristics, as well as deployment information across all four services. The descriptive analysis will also show the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder based on deployment characteristics.

## D. EFFECT OF DEPLOYMENT INTENSITY ON THE PROBABILITY OF BEING DIAGNOSED WITH PTSD, SCHIZOPHRENIA AND BIPOLAR DISORDER

Separate multivariate analysis models are used to examine the effect of deployment intensity on the probability of being diagnosed with PTSD,

schizophrenia and bipolar disorder. The sample includes all active duty service members from FY2001 to FY2011.

### 1. Theoretical Model

An observation window approach is used for analysis. This approach allows uniformed reference point(s) across all populations in observing independent variables (deployment, service and demographic characteristics). This approach also ensures that deployment characteristics are independent of the outcomes of interest (PTSD, schizophrenia and bipolar disorder). For example, a service member is considered to have been deployed in OEF/OIF missions if at least one deployment starts within the observation window.

Without this observation window approach to observe all personnel for the same amount of time, regardless of their mental health outcomes, there is a risk of the following self-selection problem: Holding all other factors constant, those who stay in the military longer tend to be healthier (and therefore would be deployed in OEF/OIF missions more during their career) than those who have serious mental health conditions (and would be discharged early in their career). Without the observation window approach described below, there will be a bias in the direction of longer and more frequent deployments being associated with lower incidences of mental health problems, because those who stay and remain healthy will have more opportunities to be deployed in OEF/OIF missions.

Due to limitations of the DEERS data on the start date of service, the observation window period varies among the following two groups:

#### *a. In-Service On or After CY2001*

All active duty service members are observed between their 8th to 48th month of service or the last date of service, whichever is earlier, for deployment characteristics. The 8th to 48th month period is chosen because newly enlisted personnel would undergo training during the initial months of enlistment, and the majority of deployments in OEF/OIF missions have been

observed to occur during this time interval[1]. The first date of entry of records in the DEERS data is used as the start date of service for all service members in-service on or after 2001. The start date of service is then used to identify the observation window period.

Service members who entered the service on or after 1 September 2007 are excluded because DEERS data provided records up to FY2011 (i.e., up to September 2011). This does not allow them to be observed for the full observation window.

### *b. In-Service Before CY2001*

The earliest date of entry of records in the DEERS data is 1 September 2000, which is an inaccurate start date of service for those who were already in service before 2001. Service members who have the earliest date of entry of records (DEERS data) in CY2000 but medical records prior to CY2000 are identified as having entered the military before CY2000. Unlike the newly enlisted group described above, this group tends to be more heterogeneous with wide distribution in terms of their length of service and ranks. Since the majority of this group would not be newly enlisted personnel who need to undergo basic training, their observation window is from their earliest date of entry from records in the DEERS data to 48 months later or the last date of service, whichever is earlier.

All service members who have an earliest date of entry from DEERS records in CY2000 and no TRICARE records prior to CY2000 are assumed to have entered the military in CY2000 as newly enlisted or commissioned. This group will be observed from the 8th to 48th month of service or the last date of service, whichever is earlier, based on the earliest date of entry of records.

[1] Based on authors' tabulations of DEERS/CTS data.

### 2. Dependent Variable

The dependent variable is a binary variable on whether a service member is diagnosed with the respective mental health disorder (PTSD, schizophrenia or bipolar disorder). The mental health disorder diagnosis information is available from the SIDR, TEDI, SADR/CAPER and TEDN. ICD-9 codes are used to classify the diagnosis information (i.e., 309.81 for PTSD; 295 for schizophrenia; and 296.0, 296.1, 296.4, 296.5, 296.6, 296.7, 296.8 and 296.89 for bipolar disorder). The dependent variable takes the value of one if the person is diagnosed with the mental health disorder after the observation window begins, until the end of FY2011, and takes the value of zero otherwise.

As the dependent variable is dichotomous, probit models are used in this thesis. Linear probability models (LPM) are not ideal, as LPMs do not constrain the dependent variable to be between zero and one. Probit models constrain the dependent variable to be between zero and one, so it is used to estimate the effect of deployment intensity on the probability of being diagnosed with PTSD, schizophrenia, and bipolar disorder.

### 3. Independent Variables

The base model for the multivariate analysis is described below:

$$P(y = 1 \mid x) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$$

where $X_1$ = deployment characteristics

$X_2$ = service and demographic characteristics

The vector $X_1$ contains the main variables of interest for the probit model. These key variables are based on deployment information from the CTS data. During the deployment period, service members may be physically sent to certain locations (for example Iraq, Afghanistan) or engaged in training elsewhere. For this study, deployment is defined as being deployed to the specific country or theater. Depending on the model, the key variables include

deployment location, deployment frequency and deployment duration. The specific key variables of interest for each respective probit model are described in a later section of this chapter.

The vector $X_2$ contains the control variables, namely the service and demographic characteristics, and year dummy variables. The same control variables are used in all probit models. Control variables that may change over time (such as Military Occupation Specialty (MOS), pay grade, marital status, age, and year dummy variables) are observed at the start of the observation window. The control variables are described below.

***Service Characteristics***

(1) Military Occupation Specialty (MOS) Codes. The MOS Code is provided in the CTS and DEERS data. The four service branches use different sets of MOS codes. The Army and Marine Corps use a MOS code, while the Air Force uses Air Force Specialty Codes (AFSC) and the Navy uses a system of naval ratings and designators along with the Naval Enlisted Classification (NEC) system. Using the different sets of military occupation codes, all observations are categorized into six military occupation categories using binary variables. The six categories are combat arms, combat service, service support, aviation, medical and other MOS. Observations with missing MOS information are grouped under “others.” See the Appendix for the six MOS categories and corresponding codes. Due to the job nature, the “combat arms” category is expected to have the largest effect on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. The reference group used in all models is the “combat arms” category.

(2) Pay Grade. The pay grade information is provided in the DEERS data. All observations are categorized into the following pay grade categories using binary variables: W1 to W5, O1 to O2, O3, O4, O5, O6, O7 to O10 for officers; and E1 to E2, E3 to E5, E6 to E9 for enlisted personnel. Each service member is assigned the pay grade they were in at the beginning of their

observation window. Observations with missing pay grade information will be categorized with the most junior pay grade category. The most junior pay grade category is used as the reference group. This means that “W1 to W5” is used as the reference group used for the officer population in the Army, Marine Corps and Navy. “O1 to O2” is the reference group for the Air Force as there are no warrant officers in the Air Force. “E1 to E2” is the reference group for all enlisted populations.

(3) Shore/Ship Deployment. This is only applicable to Navy personnel. All deployments are categorized as a binary variable “shore,” depending on whether the deployments were on shore or on ship. The binary variable “shore” takes on a value of one if the deployment was on shore, zero otherwise.

***Demographic Characteristics***

(1) Gender. The gender information is provided by the DEERS data. Observations with missing gender information are grouped under “male.” A binary variable “female” is used where it takes on a value of one if the gender is female, and zero otherwise. The reference group used is male, as the majority of the military personnel are male.

(2) Race. The race information is provided by the DEERS data and encoded into binary variables for each of the five racial/ethnic categories: White, Black, Hispanic, Asian, and other race. Observations with missing race information are grouped under “other race.” The race variables take on a value of one if the service member belongs to the race category, and zero otherwise. The reference group used is “White.”

(3) Marital Status. The marital status information is provided in the DEERS data and encoded into a binary variable “married.” It takes on a value of one if the marital status is married at the start of the observation window, and zero otherwise. The reference group used is single personnel.

(4) Age. The age and date of birth are provided in the DEERS data. The age variable is a continuous variable and reflects the age of the personnel at the start of the observation window. Observations with missing age information take on the average value of the non-missing ages.

***Year Dummy Variables***

Binary variables for each calendar year (CY2001 to CY2008) are included in the models to capture cohort changes across the years. The year dummy variables take the value of one if the observation window starts in the respective calendar year, or zero if otherwise. The reference year used is CY2000.

### 4. Base Model Specification

A total of eight probit models built on four base models are set up to test the hypotheses and estimate the effect of deployment characteristics on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. The service and demographic variables are held constant in all models. The reference groups for all eight models are made up of the personnel with no deployment in OEF/OIF missions during the observation window.

The four base models and their respective key variables of interest are described below.

#### *a. Model 1–Overall Effect of Deployment*

The first base model examines the effect of deployment in OEF/OIF missions on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. The key variable of interest is whether the person was deployed in OEF/OIF missions within the observation window. A deployment variable is encoded as a binary variable. It takes the value of one if at least one deployment occurred during the observation window, or zero if otherwise.

### *b. Model 2–Effect of Deployment Location*

The second base model examines the effect of the deployment location on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. The deployment effect is indicated by a deployment variable in Model 1 Unlike Model 1, Model 2 uses deployment location variables as an indicator for deployment in OEF/OIF missions. Deployment locations are categorized into four binary variables: (1) Afghanistan; (2) Iraq; (3) Classified or unknown countries, and; (4) Other countries under OEF/OIF missions. Each variable takes the value of one if the service member has been deployed to the location during the observation window, or zero if otherwise. Any persons who were deployed twice to two separate locations would have the value of one on both location indicators. A non-deployed service member would have the value of zero for all location indicators.

### *c. Model 3–Effect of Deployment Location and Frequency*

The third base model examines the effect of the deployment location and frequency on the probability of being diagnosed with PTSD, schizophrenia or bipolar disorder. Similar to Model 2, Model 3 also uses deployment location variables to indicate whether a service member has been deployed in OEF/OIF missions. The majority of the deployed population were only deployed in OEF/OIF missions once during the observation window. Therefore, deployment frequency is encoded as a binary variable that takes the value of one if there is more than one deployment during the observation window, or zero if otherwise.

### *d. Model 4–Effect of Deployment Location and Duration*

The fourth base model examines the effect of the deployment location and duration on the probability of being diagnosed with PTSD, schizophrenia or bipolar disorder. Based on the empirical distribution of deployed days, the total deployment duration (in days) during the observation window is

differentiated into three categories: (1) Short (less than 120 days); (2) Medium (120 to 180 days), and (3) Long (more than 180 days). Each variable takes the value of one if the deployment duration is as per the category description, or zero if otherwise.

### 5. Interaction Models' Specifications

Modifications are made to Models 1 and 2 to study how the interactions between various independent variables affect the probability of developing PTSD, schizophrenia or bipolar disorder. Four interaction models are used. The interaction models and their respective key variables of interest are described below.

#### *a. Model 5–Effect of Deployment and Deployment Period*

As described in the beginning of the chapter, one of the research questions examines whether there is a differential effect between the beginning of the GWOT and the later part (the "surge" period).The first base model is modified to examine the interactive effect of deployment period on the probability of being diagnosed with PTSD, schizophrenia or bipolar disorder. Service members who have been deployed in OEF/OIF missions are categorized into "CY 2005 and prior" and "CY2006 and after" deployment periods, based on their first deployment start dates. A dummy variable is created for each of the two periods to replace the deployment variable. Each dummy variable takes the value of one if the first deployment start date occurs during the time frame, or zero if otherwise.

#### *b. Model 6–Effect of Deployment Location and Period*

The second base model is modified to examine the effect of deployment location and period on the probability of being diagnosed with PTSD, schizophrenia or bipolar disorder. For each location, service members who have been deployed to the location are categorized into "CY2005 and prior" and

"CY2006 and after" deployment periods, based on their first deployment start date to that location. A dummy variable is created for each of the two periods to replace the original deployment location variables. Each dummy variable takes the value of one if the first deployment start date of the respective location occurs during the time frame, or zero if otherwise. For example, a service member who was first deployed to Iraq in CY2005 would be indicated as "1" under the dummy variable of "Deployed to Iraq in CY2005 and prior." A total of eight dummy variables (two for each location) are included in the model.

### *c. Model 7–Interaction Effect between Deployment and MOS*

The first base model is expanded to examine the effect of deployment in OEF/OIF missions, as well as the interaction effect of deployment in OEF/OIF missions and MOS on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. To study the effect of combat arms versus other types of MOS, we grouped all non-combat arms MOSs to generate the interaction variable included in the model. The interaction variable takes the value of one if the service member was deployed in OEF/OIF missions during the observation window and the MOS is not combat arms, or zero if otherwise.

### *d. Model 8–Interaction Effect between Deployment and Gender*

The first base model is expanded to examine the effect of deployment in OEF/OIF missions, as well as the interaction effect of deployment in OEF/OIF missions and gender on the probability of being diagnosed with PTSD, schizophrenia and bipolar disorder. An interaction variable between deployment in OEF/OIF missions and the female variable is included in the model. The interaction variable takes the value of one if the service member was deployed in OEF/OIF missions during the observation window and female, or zero if otherwise.

## E. SUMMARY

This chapter describes the analytical methodology and approaches used to examine the key research objectives in this thesis. A combination of descriptive and multivariate analyses is used to examine the effect of deployment intensity on the probability of being diagnosed with PTSD, schizophrenia or bipolar disorder. The results of the descriptive statistics and multivariate analysis models are presented and discussed in greater detail in Chapters V and VI, respectively.

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# V. DESCRIPTIVE RESULTS

## A. INTRODUCTION

This chapter presents the descriptive analysis results of this thesis. Detailed tables of descriptive analysis results are produced using the data from the Defense Enrollment Eligibility Reporting System (DEERS) and TRICARE. These tables will provide comprehensive background information regarding the service and demographic breakdown of the entire population, and deployment characteristics of the enlisted and officer populations. The tables will also include information on mental health disorder diagnosis with respect to different deployments in Operation Enduring Freedom (OEF)/Operation Iraqi Freedom (OIF) missions.

The information used is based on each service member's observation window, which varied depending on his enlistment date. As described in Chapter IV, the observation window approach is used for analysis as this approach allows unformed reference point(s) across the entire population in observing independent variables (deployment, service and demographic characteristics). This approach also ensures that deployment characteristics are independent of the outcomes of interest (PTSD, schizophrenia and bipolar disorder). For active duty service members who were in service in or after CY2001, they are observed between their 8th to 48th month of service or the last date of service, whichever is earlier, for deployment characteristics. For active duty service members who were in service before CY2001, their observation window is from their earliest date of entry from records in the DEERS data to 48 months later or the last date of service, whichever is earlier.

Section B will present the demographic and service information regarding both the enlisted and officer populations, by service and deployment status. Section C will present the deployment characteristics of both enlisted and officer populations, by service. Section D will present information on mental health

disorder diagnosis of both enlisted and officer populations, according to the different mental health disorders, by service and deployment location, frequency, and duration. Section E summarizes this chapter.

## B. SERVICE AND DEMOGRAPHIC CHARACTERISTICS

Between 2001 and 2011, 2,800,999 service members served in the U.S. military from all four services (Army, Marine Corps, Navy and Air Force). Every service member had a unique Electronic Data Interchange Person Number (EDIPN). Using the EDIPN, service and demographic information can be obtained from the various data sources described in Chapter III. Service and demographic characteristics are observed at the start of each service member's observation window.

### 1. Enlisted Population

There were 2,436,266 enlisted personnel from all four services, equivalent to approximately 87% of the total number of service members. There were 984,410 Army, 378,873 Marine, 575,986 Navy and 496,997 Air Force enlisted personnel. The proportions of enlisted personnel who had at least one deployment in OEF/OIF missions during the observation window were 48% for the Army, 49% for the Marine Corps, 42% for the Navy and 40% for the Air Force. Table 6 provides the detailed breakdown of enlisted personnel's service and demographic characteristics, by military service branch and deployment status from CY2001 to CY2011.

#### *a. Service Characteristics*

The highest proportions of deployed personnel were those serving in combat arms specialty fields in the Army and the Marines (30% and 41%, respectively). Among the non-deployed personnel, the largest MOS category

belonged to service support (28% in the Army, 34% in the Marine Corps, and 45% in the Air Force), except for the Navy where most non-deployed sailors were working in other specialty fields.

The majority of both deployed and non-deployed enlisted personnel across all services were in middle pay grades—the percentage of E3 to E5 service members ranged from 53% to 65%.

### *b. Demographic Characteristics*

Enlisted personnel from all four services were comprised mainly of males, ranging from 76% to 97%. There were more non-married than married enlisted personnel, except among Air Force non-deployed.

Most of the enlisted personnel were white, ranging from 55% to 73%. The average age of enlisted personnel ranged between 21 and 27 years. In general, deployed personnel were younger than non-deployed enlisted personnel across all four services.

Table 6. Descriptive statistics of enlisted personnel service and demographic characteristics, by military service branch and deployment status from CY2001 to CY2011

| | Army Enlisted | | | | Marine Enlisted | | | | Navy Enlisted | | | | Air Force Enlisted | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deployed | | Not Deployed | | Deployed | | Not Deployed | | Deployed | | Not Deployed | | Deployed | | Not Deployed | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Observations** | 474,051 | 48% | 510,359 | 52% | 185,565 | 49% | 193,308 | 51% | 240,611 | 42% | 335,375 | 58% | 201,245 | 40% | 295,752 | 60% |
| | 984,410 | | | | 378,873 | | | | 575,986 | | | | 496,997 | | | |
| **Service Characteristics** | | | | | | | | | | | | | | | | |
| **Military Occupational Specialty (MOS)*** | | | | | | | | | | | | | | | | |
| Combat Arms | 142,751 | 30% | 92,978 | 18% | 76,103 | 41% | 39,611 | 20% | 10,766 | 4% | 9,270 | 3% | 22,430 | 11% | 34,444 | 12% |
| Combat Service | 57,084 | 12% | 60,079 | 12% | 30,727 | 17% | 26,080 | 13% | 26,345 | 11% | 34,754 | 10% | 46,939 | 23% | 62,137 | 21% |
| Service Support | 123,953 | 26% | 144,083 | 28% | 50,767 | 27% | 64,849 | 34% | 10,671 | 4% | 18,337 | 5% | 115,038 | 57% | 134,483 | 45% |
| Aviation | 0 | 0% | 0 | 0% | 26,600 | 14% | 34,670 | 18% | 8,806 | 4% | 10,806 | 3% | 0 | 0% | 0 | 0% |
| Medical Service | 43,724 | 9% | 35,276 | 7% | 0 | 0% | 0 | 0% | 6,609 | 3% | 12,748 | 4% | 508 | 0.3% | 3,703 | 1% |
| Other MOS | 106,539 | 22% | 177,943 | 35% | 1,368 | 1% | 28,098 | 15% | 177,414 | 74% | 249,460 | 74% | 16,330 | 8% | 60,985 | 21% |
| **Pay Grade*** | | | | | | | | | | | | | | | | |
| E1 to E2 | 123,848 | 26% | 142,055 | 28% | 66,409 | 36% | 63,513 | 33% | 75,564 | 31% | 81,262 | 24% | 39,969 | 20% | 58,430 | 20% |
| E3 to E5 | 306,286 | 65% | 270,529 | 53% | 111,229 | 60% | 110,112 | 57% | 138,897 | 58% | 186,575 | 56% | 134,089 | 67% | 171,301 | 58% |
| E6 to E9 | 43,917 | 9% | 97,775 | 19% | 7,927 | 4% | 19,683 | 10% | 26,150 | 11% | 67,538 | 20% | 27,187 | 14% | 66,021 | 22% |
| **Demographic Characteristics** | | | | | | | | | | | | | | | | |
| **Gender** | | | | | | | | | | | | | | | | |
| Male | 420,441 | 89% | 398,823 | 78% | 179,360 | 97% | 176,710 | 91% | 211,322 | 88% | 276,766 | 83% | 169,481 | 84% | 224,767 | 76% |
| Female | 53,610 | 11% | 111,536 | 22% | 6,205 | 3% | 16,598 | 9% | 29,289 | 12% | 58,609 | 17% | 31,764 | 16% | 70,985 | 24% |
| **Marital Status*** | | | | | | | | | | | | | | | | |
| Non-Married | 294,002 | 62% | 292,724 | 57% | 147,861 | 80% | 134,829 | 70% | 157,267 | 65% | 194,384 | 58% | 109,890 | 55% | 147,471 | 50% |
| Married | 180,049 | 38% | 217,635 | 43% | 37,704 | 20% | 58,479 | 30% | 83,344 | 35% | 140,991 | 42% | 91,355 | 45% | 148,281 | 50% |
| **Race** | | | | | | | | | | | | | | | | |
| White | 299,277 | 63% | 294,622 | 58% | 133,192 | 72% | 130,296 | 67% | 131,822 | 55% | 200,128 | 60% | 146,130 | 73% | 208,149 | 70% |
| Black | 94,984 | 20% | 131,366 | 26% | 17,333 | 9% | 27,314 | 14% | 51,407 | 21% | 65,834 | 20% | 32,110 | 16% | 54,477 | 18% |
| Hispanic | 37,965 | 8% | 30,232 | 6% | 17,945 | 10% | 14,232 | 7% | 21,338 | 9% | 24,561 | 7% | 7,195 | 4% | 9,855 | 3% |
| Asian | 15,635 | 3% | 15,397 | 3% | 5,403 | 3% | 5,125 | 3% | 14,558 | 6% | 17,163 | 5% | 5,496 | 3% | 6,777 | 2% |
| Other Race | 26,190 | 6% | 38,742 | 8% | 11,692 | 6% | 16,341 | 8% | 21,486 | 9% | 27,689 | 8% | 10,314 | 5% | 16,494 | 6% |
| **Age*** | 24 | | 26 | | 21 | | 23 | | 24 | | 26 | | 25 | | 27 | |

*Service members' information is based on the beginning of their individual observation window.

### 2. Officer and Warrant Officer Population

There were 364,733 officers and warrant officers from all four services, which made up about 13% of the total number of service members. For the purpose of this thesis, both officers and warrant officers were classified as officers. Out of the 364,733 officers, 149,640 were from the Army, 25,734 from the Marine Corps, 80,690 from the Navy and 108,669 from the Air Force. During the observation window, the proportions of officers who had at least one deployment were 37% for the Army, 43% for the Marine Corps, 27% for the Navy and 30% for the Air Force. Table 7 provides the detailed breakdown of officers' service and demographic characteristics, by military service branch and deployment status from CY2001 to CY2011.

#### *a. Service Characteristics*

The highest proportions of deployed officers were serving in combat arms specialty fields in the Army and the Marine Corps (29% and 30%, respectively). As for non-deployed officers, the largest MOS category belonged to the other specialty fields in the Army and Air Force (28% and 99.9%, respectively). Most non-deployed officers in the Marine Corps and Navy were working in aviation and service support, respectively.

Most of the deployed officers across all services were low-ranked officers. The percentage of officers with O1 to O2 pay grades ranged from 38% to 42%. As for non-deployed officers across all services, most were in middle pay grades, except for the Marine Corps. The percentage of officers with O3 pay grade ranged from 25% to 26%.

### *b. Demographic Characteristics*

Similar to the enlisted population, most officers were males. This is the same across all four services, ranging from 78% to 94%. More officers were married than non-married across all services.

The majority of the officers were white, ranging from 73% to 85%. The average age of officers ranged between 31 and 35 years. On average, deployed officers were younger than non-deployed officers across all four services.

Table 7. Descriptive statistics of officer service and demographic characteristics, by military service branch and deployment status from CY2001 to CY2011

| | Army Officers | | | | Marine Officers | | | | Navy Officers | | | | Air Force Officers | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deployed | | Not Deployed | | Deployed | | Not Deployed | | Deployed | | Not Deployed | | Deployed | | Not Deployed | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Observations** | 56,101 | 37% | 93,539 | 63% | 10,991 | 43% | 14,743 | 57% | 21,882 | 27% | 58,808 | 73% | 32,989 | 30% | 75,680 | 70% |
| | 149,640 | | | | 25,734 | | | | 80,690 | | | | 108,669 | | | |
| **Service Characteristics** | | | | | | | | | | | | | | | | |
| **Military Occupational Specialty (MOS)*** | | | | | | | | | | | | | | | | |
| Combat Arms | 16,362 | 29% | 19,351 | 21% | 3,331 | 30% | 2,509 | 17% | 1 | 0% | 10 | 0.02% | 15 | 0.1% | 14 | 0.02% |
| Combat Service | 9,310 | 17% | 13,031 | 14% | 876 | 8% | 1,023 | 7% | 1,999 | 9% | 3,511 | 6% | 13 | 0.04% | 33 | 0.04% |
| Service Support | 11,385 | 20% | 14,810 | 16% | 3,133 | 29% | 4,281 | 29% | 19,864 | 91% | 51,901 | 88% | 34 | 0.1% | 57 | 0.1% |
| Aviation | 0 | 0% | 0 | 0% | 3,318 | 30% | 4,791 | 33% | 0 | 0% | 5 | 0.01% | 0 | 0% | 0 | 0% |
| Medical Service | 6,892 | 12% | 20,364 | 22% | 0 | 0% | 0 | 0% | 8 | 0.04% | 35 | 0.1% | 0 | 0% | 3 | 0% |
| Other MOS | 12,152 | 22% | 25,983 | 28% | 333 | 3% | 2,139 | 15% | 10 | 0.1% | 3,346 | 6% | 32,927 | 99.8% | 75,573 | 99.9% |
| **Pay Grade*** | | | | | | | | | | | | | | | | |
| Warrant Officers | 9,396 | 17% | 23,215 | 25% | 1,986 | 18% | 2,971 | 20% | 1,133 | 5% | 8,873 | 15% | 988 | 3% | 10,780 | 14% |
| O1 to O2 | 21,185 | 38% | 15,273 | 16% | 4,648 | 42% | 3,767 | 26% | 8,888 | 41% | 12,522 | 21% | 13,366 | 41% | 18,994 | 25% |
| O3 | 12,693 | 23% | 23,365 | 25% | 2,173 | 20% | 2,843 | 19% | 6,307 | 29% | 14,921 | 25% | 9,474 | 29% | 19,490 | 26% |
| O4 | 8,237 | 15% | 16,899 | 18% | 1,325 | 12% | 2,558 | 17% | 3,249 | 15% | 10,611 | 18% | 5,921 | 18% | 13,766 | 18% |
| O5 | 3,518 | 6% | 10,499 | 11% | 672 | 6% | 1,929 | 13% | 1,803 | 8% | 7,832 | 13% | 2,656 | 8% | 8,919 | 12% |
| O6 to O10 | 1,060 | 2% | 4,259 | 5% | 186 | 2% | 673 | 5% | 492 | 2% | 3,981 | 7% | 584 | 2% | 3,724 | 5% |
| **Demographic Characteristics** | | | | | | | | | | | | | | | | |
| **Gender** | | | | | | | | | | | | | | | | |
| Male | 48,895 | 87% | 75,328 | 81% | 10,378 | 94% | 13,711 | 93% | 19,055 | 87% | 48,140 | 82% | 28,185 | 85% | 59,212 | 78% |
| Female | 7,206 | 13% | 18,211 | 19% | 613 | 6% | 1,032 | 7% | 2,827 | 13% | 10,668 | 18% | 4,804 | 15% | 16,468 | 22% |
| **Marital Status*** | | | | | | | | | | | | | | | | |
| Non-Married | 22,823 | 41% | 35,743 | 38% | 4,944 | 45% | 4,457 | 30% | 10,499 | 48% | 26,821 | 46% | 13,061 | 40% | 30,202 | 40% |
| Married | 33,278 | 59% | 57,796 | 62% | 6,047 | 55% | 10,286 | 70% | 11,383 | 52% | 31,987 | 54% | 19,928 | 60% | 45,478 | 60% |
| **Race** | | | | | | | | | | | | | | | | |
| White | 43,665 | 78% | 68,704 | 73% | 9,264 | 84% | 12,102 | 82% | 17,817 | 81% | 47,871 | 81% | 28,042 | 85% | 61,508 | 81% |
| Black | 6,432 | 11% | 11,744 | 13% | 565 | 5% | 1,098 | 7% | 1,575 | 7% | 3,654 | 6% | 1,578 | 5% | 4,906 | 6% |
| Hispanic | 1,356 | 2% | 1,984 | 2% | 348 | 3% | 378 | 3% | 891 | 4% | 2,058 | 4% | 585 | 2% | 1,160 | 2% |
| Asian | 1,730 | 3% | 3,376 | 4% | 233 | 2% | 222 | 2% | 790 | 4% | 2,076 | 4% | 740 | 2% | 2,060 | 3% |
| Other Race | 2,918 | 5% | 7,731 | 8% | 581 | 5% | 943 | 6% | 809 | 4% | 3,149 | 5% | 2,044 | 6% | 6,046 | 8% |
| **Age*** | 32 | | 35 | | 31 | | 34 | | 32 | | 33 | | 32 | | 32 | |

* Service members' information is based on the beginning of their individual observation window.

## C. DEPLOYMENT CHARACTERISTICS

OEF/OIF deployment characteristics are observed during the observation window. Out of the 2,800,999 service members, 1,223,435 (44%) of them had been deployed in OEF/OIF missions. Tables 8 and 9 provide the detailed breakdown of deployment characteristics for the enlisted and officer populations, respectively, by military service branch from CY2001 to CY2011.

### 1. Enlisted Population

Out of the 2,436,266 enlisted personnel, 1,101,472 (45%) had been deployed in OEF/OIF missions at least once during the observation window. Among the four services, the proportions of deployed enlisted personnel were 48% for the Army, 49% for the Marine Corps, 42% for the Navy and 40% for the Air Force.

Deployed location varied noticeably across services: the majority of Army and Marine enlisted personnel were deployed to Iraq (41% and 57% among the deployed population, respectively), while a large share of Navy enlisted was deployed to unknown locations (44%) and two-thirds of Air Force was deployed to known locations other than Afghanistan and Iraq.

Among deployed enlisted personnel, a large proportion had only one deployment in OEF/OIF missions during the observation window. This corresponded to 82% of Army enlisted personnel, 69% of Marine enlisted personnel, 73% of Navy enlisted personnel and 67% of Air Force enlisted personnel.

With regard to the total deployed days during the observation window, with the exception of Navy, the majority of enlisted personnel from the other three services (49% for the Army, 53% for the Marine Corps and 42% for the Air Force)

were deployed in OEF/OIF missions for fewer than 120 days. A large proportion of Navy enlisted personnel (60%) were deployed in OEF/OIF missions for more than 180 days.

Most of deployed personnel were sent for their first deployment in OEF/OIF missions before CY2006. This corresponded to 61% for the Army, 56% for the Marine Corps, 71% for the Navy and 75% for the Air Force.

The majority of the Navy enlisted personnel (59%) had at least one shore-based deployment in OEF/OIF missions during the observation window.

### 2. Officer and Warrant Officer Population

Among the 364,733 officers observed, 121,963 (33%) had at least one deployment in OEF/OIF missions during the observation window. The proportions of deployed officers out of the total officer population were 63% for the Army, 57% for the Marine Corps, 73% for the Navy and 70% for the Air Force.

Like the enlisted personnel, there was also a distinct variation in deployed location among the four services. Most Army, Marine and Air Force officers were deployed to known locations other than Afghanistan and Iraq (59%, 54% and 64% among the deployed population, respectively), while a large share of Navy officers was deployed to Afghanistan (46%).

Among deployed officers, the majority were only deployed once in OEF/OIF missions during the observation window. This corresponded to 80% of Army officers, 73% of Marine officers, 76% of Navy officers and 62% of Air Force officers.

With the exception of Navy, the majority of officers from the other three services (45% for the Army, 42% for the Marine Corps and 49% for the Air Force) were deployed for fewer than 120 days. As for the Navy officers, a large proportion (47%) were deployed for more than 180 days.

Similar to enlisted personnel, large proportions of deployed personnel were first deployed before CY2006 (77% for the Army, 83% for the Marine Corps, 86% for the Navy and 83% for the Air Force).

Among Navy deployed officers, the majority (79%) were deployed on shore at least once during the observation window. This proportion was higher than the enlisted personnel's.

Table 8. Descriptive statistics of enlisted personnel deployment characteristics, by military service branch from CY2001 to CY2011

| | Army Enlisted | | Marine Enlisted | | Navy Enlisted | | Air Force Enlisted | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Deployment Status** | | | | | | | | |
| Not deployed | 510,359 | 52% | 193,308 | 51% | 335,375 | 58% | 295,752 | 60% |
| Deployed | 474,051 | 48% | 185,565 | 49% | 240,611 | 42% | 201,245 | 40% |
| **Deployment Characteristics of Deployed Population** | | | | | | | | |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 62,154 | 13% | 30,105 | 16% | 99,236 | 41% | 37,159 | 18% |
| Ever deployed to Iraq | 196,422 | 41% | 104,985 | 57% | 14,969 | 6% | 44,936 | 22% |
| Ever deployed to an unknown/classified country | 9,580 | 2% | 8,319 | 4% | 105,157 | 44% | 23,528 | 12% |
| Ever deployed to another OEF/OIF country | 258,801 | 55% | 73,679 | 40% | 51,210 | 21% | 132,817 | 66% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 389,208 | 82% | 127,864 | 69% | 176,193 | 73% | 134,175 | 67% |
| Deployed more than once | 84,843 | 18% | 57,701 | 31% | 64,418 | 27% | 67,070 | 33% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 230,551 | 49% | 99,046 | 53% | 49,720 | 21% | 83,946 | 42% |
| Medium duration (120–180 days) | 69,341 | 15% | 28,037 | 15% | 47,579 | 20% | 57,663 | 29% |
| Long duration (more than 180 days) | 174,159 | 37% | 58,482 | 32% | 143,312 | 60% | 59,636 | 30% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 288,984 | 61% | 104,723 | 56% | 170,530 | 71% | 150,411 | 75% |
| First deployment occurred in CY2006 and after | 185,067 | 39% | 80,842 | 44% | 70,081 | 29% | 50,834 | 25% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 141,157 | 59% | | |
| Ship | | | | | 118,371 | 49% | | |
| **Observations** | 984,410 | | 378,873 | | 575,986 | | 496,997 | |

*Location and type of deployment will sum up to more than 100% because some service members have multiple deployments within the observation window.

Table 9. Descriptive statistics of officer deployment characteristics, by military service branch from CY2001 to CY2011

| | Army Officer | | Marine Officer | | Navy Officer | | Air Force Officer | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Deployment Status** | | | | | | | | |
| Not deployed | 93,539 | 63% | 14,743 | 57% | 58,808 | 73% | 75,680 | 70% |
| Deployed | 56,101 | 37% | 10,991 | 43% | 21,882 | 27% | 32,989 | 30% |
| **Deployment Characteristics of Deployed Population** | | | | | | | | |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 8,848 | 16% | 2,075 | 19% | 10,043 | 46% | 8,062 | 24% |
| Ever deployed to Iraq | 18,070 | 32% | 4,103 | 37% | 1,498 | 7% | 5,235 | 16% |
| Ever deployed to an unknown/classified country | 3,113 | 6% | 695 | 6% | 6,018 | 28% | 5,955 | 18% |
| Ever deployed to another OEF/OIF country | 32,835 | 59% | 5,897 | 54% | 6,792 | 31% | 21,127 | 64% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 45,003 | 80% | 8,004 | 73% | 16,714 | 76% | 20,352 | 62% |
| Deployed more than once | 11,098 | 20% | 2,987 | 27% | 5,168 | 24% | 12,637 | 38% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 25,465 | 45% | 4,646 | 42% | 6,954 | 32% | 16,277 | 49% |
| Medium duration (120–180 days) | 8,316 | 15% | 2,157 | 20% | 4,662 | 21% | 8,175 | 25% |
| Long duration (more than 180 days) | 22,320 | 40% | 4,188 | 38% | 10,266 | 47% | 8,537 | 26% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 43,332 | 77% | 9,120 | 83% | 18,892 | 86% | 27,348 | 83% |
| First deployment occurred in CY2006 and after | 12,769 | 23% | 1,871 | 17% | 2,990 | 14% | 5,641 | 17% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 17,223 | 79% | | |
| Ship | | | | | 6,013 | 27% | | |
| **Observations** | 149,640 | | 25,734 | | 80,690 | | 108,669 | |

*Location and type of deployment will sum up to more than 100% because some service members have multiple deployments within the observation window.

## D. MENTAL HEALTH DISORDER DIAGNOSIS CHARACTERISTICS

This section discusses the prevalence rate of Post-Traumatic Stress Disorder (PTSD), schizophrenia and bipolar disorder, with respect to the military service branch, OEF/OIF deployment location, frequency and duration from CY2001 to CY2011.

The figures include only diagnoses made after the observation window begins until the end of FY2011. Out of the 2,800,999 service members, 110,771 (0.4%) were diagnosed with PTSD, 4,504 (0.02%) were diagnosed with schizophrenia and 25,878 (0.09%) were diagnosed with bipolar disorder, after the start of the observation window.

### 1. Enlisted Population

#### *a. PTSD*

Table 10 provides the number and rate of PTSD diagnoses among enlisted personnel, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. Among the 2,436,266 enlisted personnel, 104,342 (4.28%) were diagnosed with the condition. The PTSD prevalence rate was noticeably higher among deployed than non-deployed enlisted personnel across all services. The prevalence rates for the deployed and non-deployed were 10.61% and 3.45% for the Army, 6.56% and 2.02% for the Marine Corps, 2.30% and 1.64% for the Navy, and 2.37% and 1.52% for the Air Force, respectively.

Among the OEF/OIF deployment locations, enlisted personnel's PTSD prevalence rates across the four services were the highest for Iraq, ranging from 3.91% to 11.07%. The lowest PTSD prevalence rate was also the same across all four services, where deployment to an unknown/classified country had the lowest rates ranging from 1.18% to 7.57%.

PTSD was more prevalent among deployed enlisted personnel with multiple deployments (2.51% to 11.37%) than those with a single deployment.

PTSD was also more prevalent among enlisted personnel who were deployed for more than 180 days (2.41% to 10.94%). These trends were observed across all four services.

All services also showed higher percentages of being diagnosed with PTSD among enlisted personnel who had their first deployment in CY2005 or earlier. The percentage of Navy enlisted personnel diagnosed with PTSD was similar between shore-based and ship-based deployments.

Table 10. Actual number and percentage of enlisted personnel with PTSD by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Enlisted | | Marine Enlisted | | Navy Enlisted | | Air Force Enlisted | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with PTSD | 67,939 | 6.90% | 16,085 | 4.25% | 11,034 | 1.92% | 9,284 | 1.87% |
| **Deployment status** | | | | | | | | |
| Not deployed | 17,625 | 3.45% | 3,907 | 2.02% | 5,506 | 1.64% | 4,505 | 1.52% |
| Deployed | 50,314 | 10.61% | 12,178 | 6.56% | 5,528 | 2.30% | 4,779 | 2.37% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 5,224 | 8.40% | 1,751 | 5.82% | 1,697 | 1.71% | 829 | 2.23% |
| Ever deployed to Iraq | 21,753 | 11.07% | 7,650 | 7.29% | 1,579 | 10.55% | 1,759 | 3.91% |
| Ever deployed to an unknown/classified country | 725 | 7.57% | 469 | 5.64% | 1,246 | 1.18% | 388 | 1.65% |
| Ever deployed to another OEF/OIF country | 28,584 | 11.04% | 4,621 | 6.27% | 1,929 | 3.77% | 2,940 | 2.21% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 40,667 | 10.45% | 7,475 | 5.85% | 3,914 | 2.22% | 3,023 | 2.25% |
| Deployed more than once | 9,647 | 11.37% | 4,703 | 8.15% | 1,614 | 2.51% | 1,756 | 2.62% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 24,268 | 10.53% | 6,476 | 6.54% | 1,124 | 2.26% | 1,697 | 2.02% |
| Medium duration (120–180 days) | 6,985 | 10.07% | 1,592 | 5.68% | 952 | 2.00% | 1,275 | 2.21% |
| Long duration (more than 180 days) | 19,061 | 10.94% | 4,110 | 7.03% | 3,452 | 2.41% | 1,807 | 3.03% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 30,838 | 10.67% | 6,916 | 6.60% | 4,046 | 2.37% | 3,617 | 2.40% |
| First deployment occurred in CY2006 and after | 19,476 | 10.52% | 5,262 | 6.51% | 1,482 | 2.11% | 1,162 | 2.29% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 3,421 | 2.42% | | |
| Ship | | | | | 2,671 | 2.26% | | |
| **Observations** | 984,410 | | 378,873 | | 575,986 | | 496,997 | |

*Location and type of deployment may sum up to more than total number of service members because some service members have multiple deployments within the observation window.

### *b. Schizophrenia*

Table 11 provides the number and rate of schizophrenia diagnoses among enlisted personnel, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. This was a rare condition among military personnel. Among the enlisted personnel, 4,290 (0.18%) were diagnosed with schizophrenia. Schizophrenia prevalence rate was noticeably lower among deployed than non-deployed enlisted personnel across all services. Among the deployed and non-deployed, schizophrenia was prevalent among 0.19% and 0.25% of Army enlisted personnel, 0.09% and 0.19% of Marine enlisted personnel, 0.13% and 0.21% of Navy enlisted personnel, and 0.07% and 0.14% of Air Force enlisted personnel, respectively.

Among the OEF/OIF deployment locations, enlisted personnel's schizophrenia prevalence rates were the highest for other OEF/OIF countries for the Army and the Marine Corps. It was the highest for Iraq for the Navy. There was no distinctive difference for the Air Force.

In terms of deployment frequency, the schizophrenia prevalence rate was lowest among enlisted personnel with more than one deployment across all four services, ranging from 0.05% to 0.15%.

As for deployment duration, with the exception of the Army, enlisted personnel who were deployed in OEF/OIF missions for 120 to 180 days had the highest prevalence rate of schizophrenia (0.08% to 0.16%). The rate for the Army was the highest among those with fewer than 120 days (0.21%).

With regard to the deployment period, with the exception of the Army, schizophrenia was more prevalent among enlisted personnel whose first deployment was in CY2005 or earlier (0.08% to 0.14%). Among Navy enlisted personnel, the schizophrenia prevalence rate was higher among those with shore-based deployment (0.13%), compared to those with deployment on ship (0.11%).

Table 11. Actual number and percentage of enlisted personnel with schizophrenia by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Enlisted | | Marine Enlisted | | Navy Enlisted | | Air Force Enlisted | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with schizophrenia | 2,181 | 0.22% | 546 | 0.14% | 1,007 | 0.17% | 556 | 0.11% |
| **Deployment status** | | | | | | | | |
| Not deployed | 1,271 | 0.25% | 375 | 0.19% | 706 | 0.21% | 413 | 0.14% |
| Deployed | 910 | 0.19% | 171 | 0.09% | 301 | 0.13% | 143 | 0.07% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 88 | 0.14% | 20 | 0.07% | 136 | 0.14% | 25 | 0.07% |
| Ever deployed to Iraq | 341 | 0.17% | 88 | 0.08% | 22 | 0.15% | 31 | 0.07% |
| Ever deployed to an unknown/classified country | 18 | 0.19% | 5 | 0.06% | 112 | 0.11% | 8 | 0.03% |
| Ever deployed to another OEF/OIF country | 534 | 0.21% | 81 | 0.11% | 55 | 0.11% | 97 | 0.07% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 782 | 0.20% | 126 | 0.10% | 242 | 0.14% | 107 | 0.08% |
| Deployed more than once | 128 | 0.15% | 45 | 0.08% | 59 | 0.09% | 36 | 0.05% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 487 | 0.21% | 88 | 0.09% | 75 | 0.15% | 61 | 0.07% |
| Medium duration (120–180 days) | 120 | 0.17% | 40 | 0.14% | 77 | 0.16% | 47 | 0.08% |
| Long duration (more than 180 days) | 303 | 0.17% | 43 | 0.07% | 149 | 0.10% | 35 | 0.06% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 503 | 0.17% | 103 | 0.10% | 235 | 0.14% | 116 | 0.08% |
| First deployment occurred in CY2006 and after | 407 | 0.22% | 68 | 0.08% | 66 | 0.09% | 27 | 0.05% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 186 | 0.13% | | |
| Ship | | | | | 128 | 0.11% | | |
| **Observations** | 984,410 | | 378,873 | | 575,986 | | 496,997 | |

*Location and type of deployment may sum up to more than total number of service members because some service members have multiple deployments within the observation window.

### *c. Bipolar Disorder*

Table 12 provides the number and rate of bipolar disorder diagnoses among enlisted personnel, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. Out of all the observed enlisted personnel, 24,175 (0.99%) were diagnosed with bipolar disorder. The bipolar disorder prevalence rate was noticeably lower among deployed than non-deployed enlisted personnel across all services. The prevalence rates for the deployed and non-deployed were 1.33% and 1.34% for the Army, 0.57% and 0.74% for the Marine Corps, 0.56% and 0.92% for the Navy, and 0.67% and 0.93% for the Air Force, respectively.

Among the OEF/OIF deployment locations, bipolar disorder was most prevalent among Army (1.40%) and Air Force (0.73%) enlisted personnel who were deployed to another OEF/OIF country. For Marine enlisted personnel, those deployed to an unknown/classified country had the highest bipolar disorder prevalence rate (0.65%). As for Navy enlisted personnel, those deployed to Iraq had the highest bipolar disorder prevalence rate (0.73%).

Across all four services, bipolar disorder was more prevalent among enlisted personnel with one deployment in OEF/OIF missions, ranging from 0.58% to 1.35%. For deployment duration, except for the Marine Corps, bipolar disorder was more prevalent (0.66% to 1.45%) among enlisted personnel who were deployed for fewer than 120 days. For Marine enlisted personnel, the highest bipolar disorder prevalence rate (0.65%) was observed among those who were deployed for between 120 and 180 days.

Similar to schizophrenia, except for Army, bipolar disorder was more prevalent (0.58 to 0.73%) among enlisted personnel who were deployed in CY2005 and before. For Navy enlisted personnel, bipolar disorder was more prevalent among Navy enlisted personnel with shore-based deployment (0.59%), compared to those with ship-based deployment (0.54%).

Table 12. Actual number and percentage of enlisted personnel with bipolar disorder, by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Enlisted | | Marine Enlisted | | Navy Enlisted | | Air Force Enlisted | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with bipolar disorder | 13,132 | 1.33% | 2,494 | 0.66% | 4,452 | 0.77% | 4,097 | 0.82% |
| **Deployment status** | | | | | | | | |
| Not deployed | 6,848 | 1.34% | 1,440 | 0.74% | 3,096 | 0.92% | 2,755 | 0.93% |
| Deployed | 6,284 | 1.33% | 1,054 | 0.57% | 1,356 | 0.56% | 1,342 | 0.67% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 674 | 1.08% | 131 | 0.44% | 540 | 0.54% | 207 | 0.56% |
| Ever deployed to Iraq | 2,506 | 1.28% | 606 | 0.58% | 109 | 0.73% | 254 | 0.57% |
| Ever deployed to an unknown/classified country | 101 | 1.05% | 54 | 0.65% | 557 | 0.53% | 114 | 0.48% |
| Ever deployed to another OEF/OIF country | 3,636 | 1.40% | 393 | 0.53% | 322 | 0.63% | 963 | 0.73% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 5,252 | 1.35% | 795 | 0.62% | 1,030 | 0.58% | 965 | 0.72% |
| Deployed more than once | 1,032 | 1.22% | 259 | 0.45% | 326 | 0.51% | 377 | 0.56% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 3,340 | 1.45% | 596 | 0.60% | 326 | 0.66% | 634 | 0.76% |
| Medium duration (120–180 days) | 847 | 1.22% | 181 | 0.65% | 301 | 0.63% | 384 | 0.67% |
| Long duration (more than 180 days) | 2,097 | 1.20% | 277 | 0.47% | 729 | 0.51% | 324 | 0.54% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 3,505 | 1.21% | 606 | 0.58% | 1,045 | 0.61% | 1,092 | 0.73% |
| First deployment occurred in CY2006 and after | 2,779 | 1.50% | 448 | 0.55% | 311 | 0.44% | 250 | 0.49% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 828 | 0.59% | | |
| Ship | | | | | 635 | 0.54% | | |
| **Observations** | 984,410 | | 378,873 | | 575,986 | | 496,997 | |

*Location and type of deployment will sum up to more than total number of service members because some service members have multiple deployments within the observation window.

## 2. Officer and Warrant Officer Population

### *a. PTSD*

Table 13 provides the number and rate of PTSD diagnoses among officers, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. Results showed that 6,429 (1.76%) out of the 364,733 officers observed were diagnosed with PTSD. This condition was noticeably more prevalent among deployed than non-deployed officers across all services. Among deployed and non-deployed officers, 4.13% and 1.98% of the Army

officers, 2.17% and 0.99% of the Marine officers, 1.28% and 0.87% of the Navy officers, and 1.32% and 0.86% of the Air Force officers were diagnosed with PTSD, respectively.

PTSD was found to be most prevalent among Army (4.38%) and Marine (2.46%) officers who were deployed in another OEF/OIF country. As for Navy (3.27%) and Air Force (2.88%), PTSD prevalence rates were highest for those deployed in Iraq.

Unlike enlisted personnel, there was no clear trend in terms of deployment frequency in OEF/OIF missions for officers. PTSD was more prevalent among Army (4.48%) and Marine (2.51%) officers with multiple deployments, and among Navy (1.38%) and Air Force (1.51%) officers with a single deployment.

Other than Army officers, a higher percentage of officers were diagnosed with PTSD after they were deployed for a “medium” duration of 120 to 180 days (1.48% to 2.69%). PTSD was more prevalent among Army officers who were deployed for more than 180 days, at 4.51%.

All services, less the Air Force, showed a higher percentage of being diagnosed with PTSD among officers whose first deployment was in CY2005 or earlier, ranging from 1.32% to 4.40%. A higher percentage (1.34%) of Navy officers who had shore-based deployment was diagnosed with PTSD, compared to ship-based deployment (1.03%).

Table 13. Actual number and percentage of officers with PTSD, by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Officer | | Marine Officer | | Navy Officer | | Air Force Officer | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with PTSD | 4,173 | 2.79% | 384 | 1.49% | 789 | 0.98% | 1,083 | 1.00% |
| **Deployment status** | | | | | | | | |
| Not deployed | 1,855 | 1.98% | 146 | 0.99% | 509 | 0.87% | 648 | 0.86% |
| Deployed | 2,318 | 4.13% | 238 | 2.17% | 280 | 1.28% | 435 | 1.32% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 288 | 3.25% | 45 | 2.17% | 84 | 0.84% | 97 | 1.20% |
| Ever deployed to Iraq | 781 | 4.32% | 88 | 2.14% | 49 | 3.27% | 151 | 2.88% |
| Ever deployed to an unknown/classified country | 111 | 3.57% | 13 | 1.87% | 44 | 0.73% | 53 | 0.89% |
| Ever deployed to another OEF/OIF country | 1,439 | 4.38% | 145 | 2.46% | 131 | 1.93% | 215 | 1.02% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 1,821 | 4.05% | 163 | 2.04% | 230 | 1.38% | 308 | 1.51% |
| Deployed more than once | 497 | 4.48% | 75 | 2.51% | 50 | 0.97% | 127 | 1.00% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 987 | 3.88% | 74 | 1.59% | 80 | 1.15% | 195 | 1.20% |
| Medium duration (120–180 days) | 325 | 3.91% | 58 | 2.69% | 69 | 1.48% | 133 | 1.63% |
| Long duration (more than 180 days) | 1,006 | 4.51% | 106 | 2.53% | 131 | 1.28% | 107 | 1.25% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 1,908 | 4.40% | 220 | 2.41% | 249 | 1.32% | 359 | 1.31% |
| First deployment occurred in CY2006 and after | 410 | 3.21% | 18 | 0.96% | 31 | 1.04% | 76 | 1.35% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 231 | 1.34% | | |
| Ship | | | | | 62 | 1.03% | | |
| **Observations** | 149,640 | | 25,734 | | 80,690 | | 108,669 | |

*Location and type of deployment will sum up to more than total number of service members because some service members have multiple deployments within the observation window.

### *b. Schizophrenia*

Table 14 provides the number and rate of schizophrenia diagnoses among officers, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. A total of 214 officers were diagnosed with schizophrenia. This was equivalent to 0.06% of the total number of officers observed. Like enlisted personnel, the schizophrenia prevalence rate was noticeably lower among deployed than non-deployed officers across all services. Prevalence rates for the deployed and non-deployed were observed to be 0.03% and 0.08% for the Army, 0.01% and 0.05% for the Marine Corps, 0.04% and 0.08% for the Navy, and 0.02% and 0.06% for the Air Force, respectively.

Schizophrenia was most prevalent among Army (0.05%), Marine (0.02%) and Air Force (0.03%) officers who were deployed in another OEF/OIF country. For Navy officers, the schizophrenia prevalence rate was highest (0.05%) among those deployed to an unknown/classified country.

With the exception of Air Force, the proportions of officers diagnosed with schizophrenia for the other three services were higher for those with a single deployment in OEF/OIF missions, ranging from 0.01% to 0.04%, compared to those with multiple deployments.

There was no clear pattern to explain the schizophrenia prevalence rate against total number of days deployed.

Officers from all four services had a higher probability of schizophrenia among those with their first deployment in CY2005 or earlier, ranging from 0.01% to 0.04%. Schizophrenia was more prevalent among Navy officers with ship-based deployment (0.07%), compared to those with shore-based deployment (0.03%).

Table 14. Actual number and percentage of officers with schizophrenia, by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Officer | | Marine Officer | | Navy Officer | | Air Force Officer | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with schizophrenia | 96 | 0.06% | 8 | 0.03% | 55 | 0.07% | 55 | 0.05% |
| **Deployment status** | | | | | | | | |
| Not deployed | 77 | 0.08% | 7 | 0.05% | 46 | 0.08% | 47 | 0.06% |
| Deployed | 19 | 0.03% | 1 | 0.01% | 9 | 0.04% | 8 | 0.02% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 3 | 0.03% | 0 | 0% | 4 | 0.04% | 1 | 0.01% |
| Ever deployed to Iraq | 1 | 0.01% | 0 | 0% | 0 | 0% | 1 | 0.02% |
| Ever deployed to an unknown/classified country | 0 | 0% | 0 | 0% | 3 | 0.05% | 1 | 0.02% |
| Ever deployed to another OEF/OIF country | 16 | 0.05% | 1 | 0.02% | 2 | 0.03% | 6 | 0.03% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 18 | 0.04% | 1 | 0.01% | 9 | 0.05% | 4 | 0.02% |
| Deployed more than once | 1 | 0.01% | 0 | 0% | 0 | 0% | 4 | 0.03% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 10 | 0.04% | 1 | 0.02% | 1 | 0.01% | 5 | 0.03% |
| Medium duration (120–180 days) | 4 | 0.05% | 0 | 0% | 3 | 0.06% | 2 | 0.02% |
| Long duration (more than 180 days) | 5 | 0.02% | 0 | 0% | 5 | 0.05% | 1 | 0.01% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 18 | 0.04% | 1 | 0.01% | 8 | 0.04% | 8 | 0.03% |
| First deployment occurred in CY2006 and after | 1 | 0.01% | 0 | 0% | 1 | 0.03% | 0 | 0% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 5 | 0.03% | | |
| Ship | | | | | 4 | 0.07% | | |
| **Observations** | 149,640 | | 25,734 | | 80,690 | | 108,669 | |

*Location and type of deployment will sum up to more than total number of service members because some service members have multiple deployments within the observation window.

### *c. Bipolar Disorder*

Table 15 provides the number and rate of bipolar disorder diagnoses among officers, by military service branch and OEF/OIF deployment characteristics, from CY2001 to CY2011. Among the officers observed in this thesis, 1,703 (0.04%) were diagnosed with bipolar disorder. The number of cases of bipolar disorder was noticeably lower among deployed than non-deployed officers across all services, except for the Marine Corps. Prevalence rates for the deployed and non-deployed were 0.52% and 0.63% for the Army, 0.29% and 0.27% for the Marine Corps, 0.41% and 0.46% for the Navy, and 0.25% and 0.40% for the Air Force, respectively.

Bipolar disorder was more prevalent among Army (0.58%) and Marine (0.43%) officers who were deployed to an unknown/classified country. Bipolar disorder prevalence rates were highest among Navy (0.53%) and Air Force (0.36%) officers who were deployed to Iraq.

Bipolar disorder was observed to be more prevalent among officers with a single deployment in OEF/OIF missions across all four services. Among officers with a single deployment, 0.29% to 0.53% were diagnosed with bipolar disorder, compared to those with multiple deployments (0.19% to 0.49%).

No distinct pattern explaining the prevalence rate of bipolar disorder based on the total number of days deployed was observed.

Among officers from all four services, bipolar disorder was more prevalent for those with first deployment in CY2005 and prior (0.27% to 0.54%), compared to first deployment in CY2006 and after (0.14% to 0.48%). However, unlike schizophrenia, the bipolar disorder prevalence rate was slightly higher among Navy officers with shore-based deployment (0.39%), compared to those with ship-based deployment (0.38%).

Table 15. Actual number and percentage of officers with bipolar disorder, by military service branch, deployment location, frequency and duration from CY2001 to CY2011

| | Army Officer | | Marine Officer | | Navy Officer | | Air Force Officer | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Overall diagnosed with bipolar disorder | 882 | 0.59% | 72 | 0.28% | 360 | 0.45% | 389 | 0.36% |
| **Deployment status** | | | | | | | | |
| Not deployed | 588 | 0.63% | 40 | 0.27% | 271 | 0.46% | 306 | 0.40% |
| Deployed | 294 | 0.52% | 32 | 0.29% | 89 | 0.41% | 83 | 0.25% |
| **Location of deployment*** | | | | | | | | |
| Ever deployed to Afghanistan | 42 | 0.47% | 7 | 0.34% | 31 | 0.31% | 17 | 0.21% |
| Ever deployed to Iraq | 77 | 0.43% | 13 | 0.32% | 8 | 0.53% | 19 | 0.36% |
| Ever deployed to an unknown/classified country | 18 | 0.58% | 3 | 0.43% | 22 | 0.37% | 7 | 0.12% |
| Ever deployed to another OEF/OIF country | 187 | 0.57% | 17 | 0.29% | 34 | 0.50% | 54 | 0.26% |
| **Frequency of deployment** | | | | | | | | |
| Deployed once | 240 | 0.53% | 24 | 0.30% | 77 | 0.46% | 59 | 0.29% |
| Deployed more than once | 54 | 0.49% | 8 | 0.27% | 12 | 0.23% | 24 | 0.19% |
| **Total days deployed** | | | | | | | | |
| Short duration (less than 120 days) | 119 | 0.47% | 11 | 0.24% | 36 | 0.52% | 43 | 0.26% |
| Medium duration (120–180 days) | 49 | 0.59% | 7 | 0.32% | 20 | 0.43% | 27 | 0.33% |
| Long duration (more than 180 days) | 126 | 0.56% | 14 | 0.33% | 33 | 0.32% | 13 | 0.15% |
| **Deployment period** | | | | | | | | |
| First deployment occurred in CY2005 and prior | 233 | 0.54% | 28 | 0.31% | 81 | 0.43% | 75 | 0.27% |
| First deployment occurred in CY2006 and after | 61 | 0.48% | 4 | 0.21% | 8 | 0.27% | 8 | 0.14% |
| **Type of Deployment (for Navy only)*** | | | | | | | | |
| Shore | | | | | 68 | 0.39% | | |
| Ship | | | | | 23 | 0.38% | | |
| **Observations** | 149,640 | | 25,734 | | 80,690 | | 108,669 | |

*Location and type of deployment will sum up to more than total number of service members because some service members have multiple deployments within the observation window.

## E. SUMMARY

The descriptive analysis presented in this chapter will facilitate a better understanding about the characteristics of both the officer and enlisted populations of the four services, with respect to deployment in OEF/OIF missions and mental health disorder. Generally, PTSD prevalence rates were higher for both deployed officers and enlisted personnel, compared to non-deployed service members. On the contrary, schizophrenia and bipolar disorder prevalence rates were lower for the deployed groups, compared to non-deployed service members. Because schizophrenia is such a rare event in the active duty population, as shown in Tables 11 and 14, the authors exclude this condition from the multivariate analysis. Chapter VI will next present the results of the multivariate analysis models.

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# VI. MULTIVARIATE ANALYSIS RESULTS

## A. INTRODUCTION

This chapter will present and discuss the results of probit models used to examine the effect of Operation Enduring Freedom (OEF) or Operation Iraqi Freedom (OIF) deployment characteristics on the probabilities of being diagnosed with Post-Traumatic Stress Disorder (PTSD) or bipolar disorder. Separate analyses were conducted for enlisted and officer (officer and warrant officer) populations across the four services of the U.S. military, and for each of the mental health conditions. As shown in Chapter V, schizophrenia was a rare event in the active duty population. Thus, schizophrenia was excluded from the multivariate analysis.

This thesis used eight probit models for each mental health condition and population, which included four base models and four interaction models. Service and demographic variables, such as Military Occupation Specialty (MOS), pay grade, gender, race, marital status and age, were held constant in all models. Depending on the model, various key variables of interest estimated the effects of OEF/OIF deployment characteristics, such as deployment location, deployment frequency and days deployed.

The four base models are summarized below.

### 1. Model 1–Overall Effect of Deployment

The first base model examines the overall effect of deployment in OEF/OIF missions on the probabilities of being diagnosed with PTSD or bipolar disorder. The key variable of interest is whether the service member had been sent for deployment in OEF/OIF missions within the observation window.

### 2. Model 2–Effect of Deployment Location

The second model provides additional details by examining the effect of

the deployment location (Afghanistan, Iraq, an unknown/classified country, and another OEF/OIF country) on the probabilities of being diagnosed with PTSD or bipolar disorder.

### 3. Model 3–Effect of Deployment Location and Frequency

The third base model examines the effect of the OEF/OIF deployment location and having multiple OEF/OIF deployments on the probabilities of being diagnosed with PTSD or bipolar disorder.

### 4. Model 4–Effect of Deployment Location and Duration

The fourth base model examines the effect of the OEF/OIF deployment location and total days deployed within the observation window on the probabilities of being diagnosed with PTSD or bipolar disorder. The total days deployed within the observation window are divided into three categories: (1) Short (less than 120 days), (2) Medium (120 to 180 days), and (3) Long (more than 180 days).

Modifications were made to Models 1 and 2 to study how the interactions between various independent variables affected the probabilities of being diagnosed with PTSD or bipolar disorder. Four interaction models were used. The interaction models and their respective key variables of interest are summarized below.

### 5. Model 5–Interaction Effect between Deployment and Deployment Period

This model is modified from Model 1 to examine the interactive effect of deployment in OEF/OIF missions and deployment period on the probabilities of being diagnosed with PTSD or bipolar disorder. With the increase in U.S. military efforts, the number of boots on the ground increased between FY2006 and FY2010 (U.S. Library of Congress, 2011). This model aims to examine if the effect of OEF/OIF deployment differs depending on whether the service member was first deployed in CY2005 and prior, or from CY2006 to CY2010. Service

members who had been deployed are categorized into “CY2005 and prior” and “CY2006 and after” deployment periods, based on their first deployment start date within the observation window. A dummy variable is created for each of the two periods, to replace the original deployment variable.

### 6. Model 6–Interaction Effect between Deployment Location and Period

This model is modified from Model 2 to examine the effect of OEF/OIF deployment location and period on the probabilities of being diagnosed with PTSD or bipolar disorder. For each location, service members who had been deployed to that location are categorized into “CY2005 and prior” and “CY2006 and after” deployment periods, based on their first deployment start date to that location. A dummy variable is created for each of the two periods to replace the four original OEF/OIF deployment location variables. A total of eight dummy variables are included in the model.

### 7. Model 7–Interaction Effect between Deployment and MOS

Model 1 is further modified to examine the interaction effect between deployment in OEF/OIF missions and MOS on the probabilities of being diagnosed with PTSD or bipolar disorder. To study the effect of combat arms versus other types of MOS, all non-combat arms MOSs are grouped together. The interaction variable of deployment and non-combat arms MOSs is then generated.

### 8. Model 8–Interaction Effect Between Deployment and Gender

Model 1 is also modified to examine the interaction effect between deployment in OEF/OIF missions and gender on the probabilities of being diagnosed with PTSD or bipolar disorder. An interaction variable between deployment and the female variable is included in the model.

## B. ARMY ENLISTED POPULATION RESULTS

Table 16 presents the complete results of Model 1 for both PTSD and bipolar disorder among Army enlisted personnel. The key variable of interest was a binary variable "Deployed," which captured whether the service member had been sent for deployment related to OEF/OIF within the observation window. The abbreviated results of all eight models will be presented, focusing on the key deployment variables, in Tables 17 (on PTSD) and 18 (on bipolar disorder).

The probabilities of being diagnosed with PTSD or bipolar disorder were significantly dependent on whether the Army enlisted personnel was deployed as part of OEF/OIF missions ($p<0.01$). A reference Army enlisted personnel's (single white male in E1 to E2 rank, serving in combat arms specialty field) probability of being diagnosed with PTSD increased by 5.9 percentage point if deployed, compared to those not deployed. On the other hand, a reference Army enlisted personnel's probability of being diagnosed with bipolar disorder decreased by 0.15 of one percentage point if deployed, compared to those not deployed. The opposite effects observed on the deployment variable between PTSD and bipolar disorder might reflect the differences in the underlying cause of disease. PTSD is triggered by the experience of a traumatic event, while bipolar disorder is associated with a genetic disposition. With the genetic disposition, the service member might not be selected for OEF/OIF missions.

Being in combat arms and service support specialty fields generally increased an average Army enlisted personnel's probability of being diagnosed with either mental health disorder (all $p<0.01$, except service support for bipolar disorder at $p<0.1$). Being in junior pay grades (E1 to E2) also increased an average Army enlisted personnel's probability of being diagnosed with either mental health disorder ($p<0.01$).

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males, although the practical magnitudes were small. In particular, the probabilities of being diagnosed with PTSD or bipolar disorder

were 0.1 and 0.77 of one percentage point higher, respectively, for females ($p$<0.05 and $p$<0.01, respectively). Whites had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to the other racial groups ($p$<0.01). Married personnel had higher probability of being diagnosed with PTSD (2.5 percentage point) and bipolar disorder (0.31 of one percentage point), compared to non-married personnel (both $p$<0.01).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 16. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Army enlisted population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.059*** | -0.0015*** |
| | (0.001) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and E1 to E2 are the reference groups)*** | | |
| Combat Service | -0.024*** | -0.0016*** |
| | (0.001) | (0.000) |
| Service Support | -0.018*** | 0.0006* |
| | (0.001) | (0.000) |
| Medical | -0.020*** | -0.0000 |
| | (0.001) | (0.000) |
| Other MOSS | -0.023*** | -0.0014*** |
| | (0.001) | (0.000) |
| E3 to E5 | -0.005*** | -0.0019*** |
| | (0.001) | (0.000) |
| E6 to E9 | -0.019*** | -0.0068*** |
| | (0.001) | (0.000) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.001** | 0.0077*** |
| | (0.001) | (0.000) |
| Black | -0.008*** | -0.0056*** |
| | (0.001) | (0.000) |
| Hispanic | -0.004*** | -0.0055*** |
| | (0.001) | (0.000) |
| Asian | -0.015*** | -0.0045*** |
| | (0.001) | (0.000) |
| Other Race | 0.000 | -0.0051*** |
| | (0.001) | (0.000) |
| Married | 0.025*** | 0.0031*** |
| | (0.001) | (0.000) |
| Age | 0.000*** | -0.0000 |
| | (0.000) | (0.000) |
| Missing age indicator | -0.048*** | -0.0074*** |
| | (0.001) | (0.000) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | -0.008*** | -0.0017*** |
| | (0.001) | (0.000) |
| CY2002 | -0.004*** | -0.0013*** |
| | (0.001) | (0.000) |
| CY2003 | -0.004*** | -0.0027*** |
| | (0.001) | (0.000) |
| CY2004 | -0.001 | -0.0013*** |
| | (0.001) | (0.000) |
| CY2005 | 0.003*** | 0.0009* |
| | (0.001) | (0.000) |
| CY2006 | 0.000 | 0.0021*** |
| | (0.001) | (0.001) |
| CY2007 | -0.017*** | 0.0014*** |
| | (0.001) | (0.000) |
| CY2008 | -0.027*** | -0.0011* |
| | (0.001) | (0.001) |
| Observed Probability | 0.069 | 0.0133 |
| Predicted Probability | 0.056 | 0.0122 |
| Observations | 984,410 | 984,410 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 17 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 16 are reproduced for comparison purposes.

Model 2 investigated the effect of OEF/OIF deployment location on the probability of being diagnosed with PTSD. Deployment to any OEF/OIF location (Afghanistan, Iraq, an unknown/classified country or another OEF/OIF country) increased the probability of being diagnosed with PTSD, compared to non-deployed ($p$<0.01). The magnitude of increase was the highest at 5.4 percentage point if deployed to another OEF/OIF country. This was followed by an increase of 5.2 percentage points if deployed to Iraq, 1.9 percentage points if deployed to Afghanistan, and the lowest increase of 0.9 of one percentage point if deployed to an unknown/classified country. All of the pairwise location coefficient comparisons were significant ($p$< 0.01).

Model 3 investigated whether there was a difference in the deployment effect between those with a single deployment, and those with multiple deployments within the observation window. Results showed that having multiple deployments decreased the probability of being diagnosed with PTSD by 1.9 percentage point, compared to an average Army enlisted personnel with a single deployment ($p< 0.01$).

Model 4 investigated the relationship between days deployed and the probability of being diagnosed with PTSD. The probability of being diagnosed with PTSD increased by 0.3 of one percentage point for Army enlisted personnel with 120 to 180 days of deployment in OEF/OIF missions, and by 0.5 of one percentage point if deployed more than 180 days within the observation window, compared to those with fewer than 120 days (both $p<0.01$).

Model 5 investigated whether there were differences in the deployment effect between those whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and those who were deployed for the first time in CY2006 and after. The probability of being diagnosed with PTSD increased by 6.4 percentage points for Army enlisted personnel whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 8.4 percentage points for those whose first deployment in OEF/OIF missions occurred in CY2006 and after, compared to those not deployed. The coefficient estimates for the two periods were found to be statistically different from each other ($p<0.01$).

Model 6 refined Model 5's specification by comparing the coefficient estimates of deployed locations by periods. In general, the OEF/OIF deployment location effects were higher among those whose first deployment in OEF/OIF missions to a given location occurred in CY2006 and after. The differences between the two periods for all locations were statistically significant ($p< 0.01$).

Model 7 expanded Model 1 and investigated whether the deployment effect was magnified or moderated by MOS categories. The results showed that the interaction effect between deployment in OEF/OIF missions and non-combat

arms MOSs was statistically significant ($p$<0.01). This meant that the probability of being diagnosed with PTSD significantly decreased by 0.4 of one percentage point if the deployed Army enlisted personnel was from non-combat arms MOSs, compared to those deployed and from combat arms MOSs.

Model 8 expanded Model 1 and investigated whether there was differential effect by gender. Results showed that the interaction effect between deployment in OEF/OIF missions and being female was negative ($p$<0.01). The coefficient estimates suggested that the probability of being diagnosed with PTSD decreased by 1.6 percentage points if the deployed Army enlisted personnel was female, compared to male counterparts.

### 2. Bipolar Disorder

Table 18 presents the marginal effects of key variables of interest on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 16 are reproduced for comparison purposes.

Model 2 investigated the effect of OEF/OIF deployment location on the probability of being diagnosed with bipolar disorder. Deployment to Afghanistan, Iraq or an unknown/classified country was associated with reduced probability of being diagnosed with bipolar disorder, compared to non-deployed ($p$<0.01 for Afghanistan and Iraq, $p$<0.1 for an unknown/classified country). An average Army enlisted personnel's probability of being diagnosed with bipolar disorder decreased by 0.31 of one percentage point if deployed to Afghanistan, by 0.18 of one percentage point if deployed to Iraq, and by 0.20 of one percentage point if deployed to an unknown/classified country. Similar to PTSD, the probability of being diagnosed with bipolar disorder was significantly higher if he was ever deployed to Iraq, as compared to Afghanistan ($p$<0.01).

Model 3 investigated whether there was a difference in the deployment effect between those with a single deployment in OEF/OIF missions, and those with multiple deployments within the observation window. Results showed that

having multiple deployments was not associated with significantly different probability of being diagnosed with bipolar disorder for Army enlisted personnel ($p<0.1$).

Model 4 investigated the relationship between days deployed and the probability of being diagnosed with bipolar disorder. More days deployed was associated with reduced probability of being diagnosed with bipolar disorder. The probability of being diagnosed with bipolar disorder decreased by 0.12 of one percentage point for Army enlisted personnel with 120 to 180 days of deployment in OEF/OIF missions ($p<0.01$), and by 0.07 of one percentage point if the service member was deployed for more than 180 days within the observation window, compared to those with fewer than 120 days ($p<0.05$).

Model 5 investigated whether the association between deployment in OEF/OIF missions and the probability of being diagnosed with bipolar disorder differed between those whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and those who were deployed for the first time in CY2006 and after. No statistically significant difference between the two periods was found.

Model 6 refined Model 5's specification by comparing the coefficient estimates of deployed locations by periods. Those whose first deployment to Iraq in CY2005 and prior were associated with a higher probability of being diagnosed with bipolar disorder, compared to those whose first deployment to Iraq occurred in CY2006 and after ($p<0.01$). The reverse trend was observed for an unknown/classified country, where lower probability of being diagnosed with bipolar disorder was associated with those whose first deployment to an unknown/classified country occurred in CY2005 and prior ($p<0.01$).

Model 7 expanded Model 1 and investigated whether the deployment effect was magnified or moderated by MOS categories. The results showed that the interaction effect between deployment in OEF/OIF missions and non-combat arms MOSs was associated with a higher probability of bipolar disorder ($p<0.01$). This meant that the probability of being diagnosed with bipolar disorder increased

by 0.09 of one percentage point if the deployed Army enlisted personnel was from non–combat arms MOSs, compared to those deployed and from combat arms MOSs.

Model 8 expanded Model 1 and investigated whether there was differential effect by gender. The results showed that the interaction effect between deployment in OEF/OIF missions and being female was not statistically significant.

Table 17. Marginal effect of key variables of interest on probability of being diagnosed with PTSD (Army enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.059*** | - | - | - | - | - | 0.062*** | 0.062*** |
| | (0.001) | | | | | | (0.001) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.064*** | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred n CY2006 and after | - | - | - | - | 0.084*** | - | - | - |
| | | | | | (0.001) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.019*** | 0.030*** | 0.017*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.052*** | 0.061*** | 0.049*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to an unknown/classified country | - | 0.009*** | 0.021*** | 0.009*** | - | - | - | - |
| | | (0.003) | (0.003) | (0.002) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.054*** | 0.063*** | 0.052*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.019*** | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.003*** | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.005*** | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.010*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.038*** | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.002) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.053*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.060*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.004* | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.049*** | - | - |
| | | | | | | (0.009) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.055*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.067*** | - | - |
| | | | | | | (0.001) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.004*** | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.016*** |
| | | | | | | | | (0.001) |
| Observed Probability | 0.069 | 0.069 | 0.069 | 0.069 | 0.069 | 0.069 | 0.069 | 0.069 |
| Predicted Probability | 0.056 | 0.057 | 0.057 | 0.057 | 0.056 | 0.057 | 0.056 | 0.056 |
| Observations | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 18. Marginal effect of key variables of interest on probability of being diagnosed with bipolar disorder (Army enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0015*** | - | - | - | - | - | -0.0022*** | -0.0016*** |
| | (0.000) | | | | | | (0.000) | (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0014*** | - | - | - |
| | | | | | (0.000) | | | |
| First deployment occurred n CY2006 and after | - | - | - | - | -0.0017*** | - | - | - |
| | | | | | (0.000) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0031*** | -0.0031*** | -0.0027*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| Ever deployed to Iraq | - | -0.0018*** | -0.0018*** | -0.0013*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| Ever deployed to an unknown/classified country | - | -0.0020* | -0.0020* | -0.0019* | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | -0.0003 | -0.0003 | 0.0000 | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | 0.0000 | - | - | - | - | - |
| | | | (0.000) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.0012*** | - | - | - | - |
| | | | | (0.000) | | | | |
| Long duration (more than 180 days) | - | - | - | -0.0007** | - | - | - | - |
| | | | | (0.000) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0028*** | - | - |
| | | | | | | (0.001) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | -0.0035*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | -0.0011*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | -0.0026*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0028*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.0029 | - | - |
| | | | | | | (0.003) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0004 | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0003 | - | - |
| | | | | | | (0.000) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.0009* | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | 0.0002 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| Predicted Probability | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| Observations | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 | 984,410 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## C. ARMY OFFICER POPULATION RESULTS

Table 19 presents the complete results of Model 1 for both PTSD and bipolar disorder among Army officers. The key variable of interest was whether the service member was deployed on OEF/OIF missions within the observation window.

The probabilities of being diagnosed with PTSD or bipolar disorder were significantly dependent on whether an Army officer was deployed as part of OEF/OIF missions ($p<0.01$ and $p<0.05$, respectively). A reference Army officer's (single white male warrant officer who served in combat arms specialty field) probability of being diagnosed with PTSD increased by 1.9 percentage points if deployed, compared to those not deployed. On the other hand, a reference Army officer's probability of being diagnosed with bipolar disorder decreased by 0.09 of one percentage point among the deployed population, compared to those not deployed.

Being in a combat arms specialty fields increased an average Army officer's probability of being diagnosed with PTSD, compared to those in combat service or other MOSs ($p<0.1$ and $p<0.05$, respectively). Army officers in medical specialty fields had higher probability of being diagnosed with PTSD compared to combat arms ($p<0.1$). As for bipolar disorder, the probabilities were higher for Army officers in service support or medical specialty fields, compared to those in combat arms ($p<0.05$ and $p<0.01$, respectively).

Being in middle and senior pay grades (O3 to O10) generally decreased an average Army officer's probability of being diagnosed with PTSD, compared to those in junior pay grades (W1 to O2) ($p<0.01$). As for bipolar disorder, the probabilities were higher for Army officers in O1 to O2, and O3 pay grades ($p<0.01$ and $p<0.05$, respectively). The probability of being diagnosed with bipolar disorder was lower for those in senior pay grades (O5 to O10) ($p<0.01$).

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males. The probabilities of being diagnosed with PTSD or bipolar disorder were 0.7 and 0.44 of one percentage point higher, respectively, for females (both $p<0.01$). Married personnel had higher probability of being diagnosed with PTSD by 0.3 of one percentage point, compared to non-married personnel ($p<0.01$).

In terms of race, the probabilities of being diagnosed with PTSD for blacks, Hispanics and other races were 1.0, 1.4 and 0.5 of one percentage point higher respectively, compared to whites ($p<0.01$). As for bipolar disorder, whites had higher probability of being diagnosed with bipolar disorder by 0.11 of one percentage point, compared to blacks ($p<0.05$). Hispanics had the highest probability of being diagnosed with bipolar disorder of 0.36 of one percentage point higher than whites ($p<0.05$).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 19. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Army officer population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.019*** | -0.0009** |
| | (0.001) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and W1 to W5 are the reference groups)*** | | |
| Combat Service | -0.002* | 0.0004 |
| | (0.001) | (0.001) |
| Service Support | 0.002 | 0.0014** |
| | (0.001) | (0.001) |
| Medical | 0.002* | 0.0025*** |
| | (0.001) | (0.001) |
| Other MOS | -0.003** | -0.0004 |
| | (0.001) | (0.001) |
| O1 to O2 | 0.001 | 0.0018*** |
| | (0.001) | (0.001) |
| O3 | -0.005*** | 0.0016** |
| | (0.001) | (0.001) |
| O4 | -0.008*** | 0.0005 |
| | (0.001) | (0.001) |
| O5 | -0.016*** | -0.0023*** |
| | (0.001) | (0.001) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| O6 to O10 | -0.019*** | -0.0025*** |
| | (0.001) | (0.001) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.007*** | 0.0044*** |
| | (0.001) | (0.001) |
| Black | 0.010*** | -0.0011** |
| | (0.001) | (0.000) |
| Hispanic | 0.014*** | 0.0036** |
| | (0.003) | (0.002) |
| Asian | -0.003* | -0.0001 |
| | (0.002) | (0.001) |
| Other Race | 0.005*** | -0.0000 |
| | (0.002) | (0.001) |
| Married | 0.003*** | 0.0000 |
| | (0.001) | (0.000) |
| Age | 0.001*** | 0.0001*** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.021*** | -0.0038*** |
| | (0.001) | (0.000) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | 0.000 | 0.0004 |
| | (0.001) | (0.001) |
| CY2002 | -0.000 | -0.0004 |
| | (0.001) | (0.001) |
| CY2003 | -0.006*** | -0.0025*** |
| | (0.001) | (0.000) |
| CY2004 | -0.008*** | -0.0015** |
| | (0.001) | (0.001) |
| CY2005 | -0.007*** | -0.0014** |
| | (0.001) | (0.001) |
| CY2006 | -0.012*** | -0.0027*** |
| | (0.001) | (0.001) |
| CY2007 | -0.014*** | -0.0030*** |
| | (0.001) | (0.001) |
| CY2008 | -0.018*** | -0.0044*** |
| | (0.001) | (0.000) |
| Observed Probability | 0.028 | 0.0059 |
| Predicted Probability | 0.023 | 0.0050 |
| Observations | 149,640 | 149,640 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | |

## 1. PTSD

Table 20 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 19 were reproduced for comparison purposes.

Model 2 showed that deployment to any OEF/OIF location (Afghanistan, Iraq, an unknown/classified country or another OEF/OIF country) increased the probability of being diagnosed with PTSD, compared to non-deployed ($p$<0.01 for Afghanistan, Iraq and another OEF/OIF country, $p$<0.1 for an unknown/classified country). The magnitude of increase was the highest at 1.8 percentage point if deployed to Iraq or another OEF/OIF country, followed by an increase of 0.5 of one percentage point if deployed to Afghanistan or an unknown/classified country. The pairwise location coefficient comparisons were significant ($p$<0.01).

Model 3 showed that having multiple deployments in OEF/OIF missions decreased the probability of an average Army officer being diagnosed with PTSD by 0.4 of one percentage point, compared to those with a single deployment ($p$<0.01).

Model 5 showed stronger effect of deployment in OEF/OIF missions on PTSD for those who were deployed after CY2005. The probability of being diagnosed with PTSD increased by 1.8 percentage points for Army officers whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 3.4 percentage points for those whose first deployment in OEF/OIF missions occurred in CY2006 and after. The difference between the coefficient estimates of the two periods was found to be statistically significant ($p$<0.01).

Model 6 showed that the OEF/OIF deployment location effects were higher among those whose first deployment to any OEF/OIF location occurred in CY2006 and after, compared to those whose first deployment to the same location occurred in CY2005 and before (all $p$<0.05, except for Iraq at $p$<0.01).

Model 7 showed that the interaction effect between deployment in OEF/OIF missions and non-combat arms MOSs was statistically significant ($p$<0.05). This meant that the probability of being diagnosed with PTSD significantly increased by 0.5 percentage point if the deployed Army officer was from a non-combat arms MOS, compared to those deployed and from combat arms MOSs.

Models 4 and 8 showed that the number of days deployed and the interaction effect between gender and deployment in OEF/OIF missions had no significant effects on the probability of being diagnosed with PTSD for the Army officer population.

### 2. Bipolar Disorder

Table 21 presents the marginal effects of key variables of interests on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 19 are reproduced for comparison purposes.

Model 2 showed that deployment to Iraq was associated with a lower probability of being diagnosed with bipolar disorder for Army officers by 0.14 of one percentage point, compared to those not deployed ($p<0.01$).

Model 5 showed that first deployment in OEF/OIF missions in CY2005 and prior was associated with a lower probability of being diagnosed with bipolar disorder. The probability of being diagnosed with bipolar disorder was significantly lower by 0.12 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2005 and prior, compared to those not deployed ($p<0.01$). The coefficient estimate for those whose first deployment in OEF/OIF missions occurred in CY2006 and after was not significant. The difference between the coefficient estimates of the two periods was found to be statistically significant ($p<0.01$).

Model 6 showed that first deployment to Iraq in CY2005 and prior was associated with a lower probability of being diagnosed with bipolar disorder, compared to first deployment to the same location in CY2006 and after ($p<0.01$).

Models 3 and 4 also showed that deployment frequency and the number of days deployed were not associated with the probability of being diagnosed with bipolar disorder for Army officers. Models 7 and 8 also indicated that the interaction effects between deployment in OEF/OIF missions and non-combat

arms MOSs, and deployment in OEF/OIF missions and female, were not statistically significant.

Table 20. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Army officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.019*** | - | - | - | - | - | 0.014*** | 0.018*** |
| | (0.001) | | | | | | (0.002) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.018*** | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.034*** | - | - | - |
| | | | | | (0.003) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.005*** | 0.006*** | 0.004** | - | - | - | - |
| | | (0.002) | (0.002) | (0.002) | | | | |
| Ever deployed to Iraq | - | 0.018*** | 0.020*** | 0.018*** | - | - | - | - |
| | | (0.002) | (0.002) | (0.002) | | | | |
| Ever deployed to an unknown/classified country | - | 0.005* | 0.007** | 0.005* | - | - | - | - |
| | | (0.003) | (0.003) | (0.003) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.018*** | 0.019*** | 0.018*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.004*** | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.001 | - | - | - | - |
| | | | | (0.002) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.000 | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.003* | - | - |
| | | | | | | (0.002) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.015** | - | - |
| | | | | | | (0.006) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.016*** | - | - |
| | | | | | | (0.002) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.031*** | - | - |
| | | | | | | (0.004) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.002 | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.024** | - | - |
| | | | | | | (0.010) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.017*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.025*** | - | - |
| | | | | | | (0.003) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.005** | - |
| | | | | | | | (0.002) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | 0.001 |
| | | | | | | | | (0.002) |
| Observed Probability | 0.028 | 0.028 | 0.028 | 0.028 | 0.028 | 0.028 | 0.028 | 0.028 |
| Predicted Probability | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| Observations | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models

Table 21. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Army officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0009** | - | - | - | - | - | -0.0015** | -0.0008* |
| | (0.000) | | | | | | (0.001) | (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0012*** | - | - | - |
| | | | | | (0.000) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.0016 | - | - | - |
| | | | | | (0.001) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0009 | -0.0009 | -0.0012* | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | -0.0014*** | -0.0014*** | -0.0017*** | - | - | - | - |
| | | (0.000) | (0.001) | (0.001) | | | | |
| Ever deployed to an unknown/classified country | - | 0.0003 | 0.0003 | 0.0002 | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | -0.0005 | -0.0004 | -0.0007 | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0000 | - | - | - | - | |
| | | | | | | | | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.0008 | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.0006 | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0012* | - | - |
| | | | | | | (0.001) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.0015 | - | - |
| | | | | | | (0.002) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | -0.0022*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.0018 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.0003 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.0005 | - | - |
| | | | | | | (0.004) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0006 | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.0008 | - | - |
| | | | | | | (0.001) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.0010 | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.0002 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Predicted Probability | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Observations | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 | 149,640 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models

## D. MARINE ENLISTED POPULATION RESULTS

Table 22 presents the complete results of Model 1 for both PTSD and bipolar disorder among Marine enlisted personnel. The key variable of interest was whether the service member had been sent for OEF/OIF deployment within the observation window.

There were many parallels between the Army and Marine enlisted results. The probabilities of being diagnosed with PTSD and bipolar disorder were significantly dependent on whether the Marine enlisted personnel was sent for deployment in OEF/OIF missions (both $p<0.01$). A reference Marine enlisted personnel's (single white male in E1 to E2 rank, serving in combat arms specialty field) probability of being diagnosed with PTSD increased by 3.5 percentage points if deployed, compared to those not deployed. On the other hand, a reference Marine enlisted personnel's probability of being diagnosed with bipolar disorder decreased by 0.21 of one percentage point among the deployed population, compared to those not deployed.

Being in a combat arms specialty fields generally increased an average Marine enlisted personnel's probability of being diagnosed with PTSD ($p<0.01$). As for bipolar disorder, Marine enlisted personnel in combat service and service support fields had higher probability of being diagnosed with bipolar disorder, compared to all other specialty fields ($p<0.01$).

Being in middle and senior pay grades (E3 to E9) generally decreased an average Marine enlisted personnel's probability of being diagnosed with bipolar disorder, compared to those in junior pay grades ($p<0.01$).

In terms of demographics, females had higher probabilities of being diagnosed with PTSD or bipolar disorder by 2.3 and 0.86 of one percentage point, respectively, compared to males ($p<0.01$). Whites had higher probabilities of being diagnosed with PTSD or bipolar disorder compared to the other racial minority groups (all $p<0.01$, except for other race, $p<0.05$). Married personnel

had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to non-married personnel (2.1 and 0.19 of one percentage point, respectively, both $p<0.01$).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 22. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Marine enlisted population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.035*** | -0.0021*** |
| | (0.001) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and E1 to E2 are the reference groups)*** | | |
| Combat Service | -0.013*** | 0.0017*** |
| | (0.001) | (0.000) |
| Service Support | -0.011*** | 0.0011*** |
| | (0.001) | (0.000) |
| Aviation | -0.026*** | 0.0004 |
| | (0.001) | (0.000) |
| Other MOS | -0.014*** | -0.0002 |
| | (0.001) | (0.001) |
| E3 to E5 | 0.001 | -0.0009*** |
| | (0.001) | (0.000) |
| E to E9 | -0.001 | -0.0025*** |
| | (0.002) | (0.001) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.023*** | 0.0086*** |
| | (0.002) | (0.001) |
| Black | -0.002*** | -0.0019*** |
| | (0.001) | (0.000) |
| Hispanic | -0.003*** | -0.0028*** |
| | (0.001) | (0.000) |
| Asian | -0.008*** | -0.0033*** |
| | (0.001) | (0.000) |
| Other Race | -0.003** | -0.0025*** |
| | (0.001) | (0.000) |
| Married | 0.021*** | 0.0019*** |
| | (0.001) | (0.000) |
| Age | 0.000 | -0.0001** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.027*** | -0.0039*** |
| | (0.001) | (0.000) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | -0.003** | 0.0001 |
| | (0.001) | (0.000) |
| CY2002 | 0.006*** | 0.0009 |
| | (0.001) | (0.001) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| CY2003 | 0.007*** | -0.0000 |
| | (0.001) | (0.001) |
| CY2004 | 0.017*** | 0.0008 |
| | (0.001) | (0.001) |
| CY2005 | 0.014*** | 0.0014** |
| | (0.001) | (0.001) |
| CY2006 | 0.007*** | 0.0014** |
| | (0.001) | (0.001) |
| CY2007 | -0.002* | 0.0021*** |
| | (0.001) | (0.001) |
| CY2008 | -0.006*** | 0.0019** |
| | (0.001) | (0.001) |
| Observed Probability | 0.042 | 0.0066 |
| Predicted Probability | 0.033 | 0.0059 |
| Observations | 378,873 | 378,873 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 23 presents the marginal effects of key variables of interests on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 22 are reproduced for comparison purposes.

Model 2 showed that deployment to any OEF/OIF location (Afghanistan, Iraq, an unknown/classified country or another OEF/OIF country) was associated with a higher probability of being diagnosed with PTSD, compared to non-deployed ($p$<0.01). The magnitude of increase was the greatest at 2.9 percentage points if deployed to Iraq. This was followed by an increase of 2.5 percentage points if deployed to another OEF/OIF country, and by 2.1 percentage points if deployed to Afghanistan or an unknown/classified country. All of the pairwise location coefficient comparisons were significant ($p$<0.01), except between Afghanistan and an unknown/classified country.

Model 3 showed that having multiple deployments in OEF/OIF missions was associated with a higher probability of being diagnosed with PTSD by 0.2 of one percentage point, compared to an average Marine enlisted personnel with a single deployment ($p$<0.1).

Model 4 showed that the probability of being diagnosed with PTSD increased by 0.4 of one percentage point for Marine enlisted personnel with 120 to 180 days of deployment, and by 0.8 of one percentage point if deployed more than 180 days within the observation window, compared to those with fewer than 120 days (both $p<0.01$).

Model 5 showed that the probability of being diagnosed with PTSD increased by 4.4 percentage points for Marine enlisted personnel whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 3.8 percentage points for those whose first deployment in OEF/OIF missions occurred in CY2006 and after. The coefficient estimates for the two periods were found to be statistically different ($p<0.01$).

Model 6 showed that the OEF/OIF deployment location effect was higher among those whose first deployment to Afghanistan occurred in CY2006 and after, compared to those whose first deployment to Afghanistan occurred in CY2005 and prior ($p<0.01$). The findings were opposite for Iraq and another OEF/OIF country (both $p<0.01$).

Model 7 showed that the probability of being diagnosed with PTSD significantly decreased by 0.5 of one percentage point if the deployed Marine enlisted personnel was from a non-combat arms MOS, compared to those deployed and from combat arms MOSs ($p<0.01$).

Model 8 suggested that the probability of being diagnosed with PTSD decreased by 1.5 percentage points if the deployed Marine enlisted personnel was female, compared to male counterparts ($p<0.01$).

### 2. Bipolar Disorder

Table 24 presents the marginal effects of key variables of interests on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 22 are reproduced for comparison purposes.

Model 2 showed that deployment to Afghanistan, Iraq or another OEF/OIF country was associated with a lower probability of being diagnosed with bipolar disorder, compared to non-deployed. In particular, the probability of being diagnosed with bipolar disorder decreased by 0.23, 0.18 and 0.16 of one percentage point if deployed to Afghanistan, Iraq and another OEF/OIF country, respectively, compared to non-deployed (all $p<0.01$). The location coefficient comparisons for Afghanistan and an unknown/classified country, Afghanistan and another OEF/OIF country, and Iraq and another OEF/OIF country were significant ($p<0.01$, $p<0.1$ and $p<0.01$, respectively).

Model 3 showed that having multiple deployments to OEF/OIF missions was associated with a lower probability of being diagnosed with bipolar disorder by 0.09 of one percentage point, compared to an average Marine enlisted personnel with a single deployment in OEF/OIF missions ($p<0.05$).

Model 4 showed that being deployed for 120 to 180 days was associated with a higher probability of being diagnosed with bipolar disorder, by 0.15 of one percentage point, compared to those being deployed for fewer than 120 days ($p<0.05$).

Results of Model 5 showed that the probability of being diagnosed with bipolar disorder was reduced by 0.09 of one percentage point for Marine enlisted personnel whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 0.32 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2006 and after. The coefficient estimates for the two periods were found to be significantly different ($p<0.01$).

Model 6 showed that the first deployment to Afghanistan, Iraq, and another OEF/OIF country occurring in CY2006 and after was associated with a higher probability of being diagnosed with bipolar disorder, compared to those whose first deployment to the same locations occurred in CY2005 and prior ($p<0.01$ for Afghanistan and Iraq, $p<0.05$ for another OEF/OIF country).

Models 7 and 8 showed that the interaction effects between deployment in OEF/OIF missions and non-combat arms MOSs, and deployment in OEF/OIF missions and female, were not statistically significant.

Table 23. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Marine enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.035*** | - | - | - | - | - | 0.038*** | 0.036*** |
| | (0.001) | | | | | | (0.001) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.044*** | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.038*** | - | - | - |
| | | | | | (0.001) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.021*** | 0.019*** | 0.016*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.029*** | 0.028*** | 0.027*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to an unknown/classified country | - | 0.021*** | 0.020*** | 0.019*** | - | - | - | - |
| | | (0.003) | (0.003) | (0.002) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.025*** | 0.024*** | 0.021*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | 0.002* | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.004*** | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.008*** | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.017*** | - | - |
| | | | | | | (0.002) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.029*** | - | - |
| | | | | | | (0.002) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.036*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.027*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.019*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.027*** | - | - |
| | | | | | | (0.005) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.033*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.010*** | - | - |
| | | | | | | (0.002) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.005*** | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.015*** |
| | | | | | | | | (0.001) |
| Observed Probability | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| Predicted Probability | 0.033 | 0.033 | 0.033 | 0.033 | 0.033 | 0.033 | 0.033 | 0.033 |
| Observations | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 24. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Marine enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0021*** | - | - | - | - | - | -0.0024*** | -0.0021*** |
| | (0.000) | | | | | | (0.000) | (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0009*** | - | - | - |
| | | | | | (0.000) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | -0.0032*** | - | - | - |
| | | | | | (0.000) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0023*** | -0.0021*** | -0.0025*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| Ever deployed to Iraq | - | -0.0018*** | -0.0015*** | -0.0018*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| Ever deployed to an unknown/classified country | - | -0.0002 | 0.0000 | -0.0005 | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | -0.0016*** | -0.0013*** | -0.0017*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0009** | - | - | - | - | - |
| | | | (0.000) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.0015** | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | -0.0001 | - | - | - | - |
| | | | | (0.000) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0008 | - | - |
| | | | | | | (0.001) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | -0.0041*** | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.000) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | -0.0004 | - | - |
| | | | | | | (0.000) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | -0.0026*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.0005 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.0019 | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0011*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0024*** | - | - |
| | | | | | | (0.000) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.0004 | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.0004 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| Predicted Probability | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Observations | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 | 378,873 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## E. MARINE OFFICER POPULATION RESULTS

Table 25 presents the complete results of Model 1 for both PTSD and bipolar disorder among Marine officers. The key variable of interest was whether the service member had been deployed in OEF/OIF missions within the observation window.

The probability of a reference Marine officer (single white male warrant officer who served in combat arms specialty field) being diagnosed with PTSD increased by 1.0 percentage point if deployed, compared to those not deployed ($p<0.01$). On the other hand, deployment in OEF/OIF missions was also not associated with the probability of being diagnosed with bipolar disorder.

Marine officers in combat arms specialty fields had higher probability of being diagnosed with PTSD, compared to aviation and other MOSs ($p<0.01$). Higher pay grades were associated with a lower probability of being diagnosed with PTSD ($p<0.01$ for O3 and O4, $p<0.10$ for O6, with the reference pay grade being warrant officer). There was no significant effect of MOS and pay grade on the probability of being diagnosed with bipolar disorder.

In terms of demographics, females had higher probabilities of being diagnosed with PTSD or bipolar disorder by 1.4 and 0.54 of one percentage point, respectively, compared to males ($p<0.01$ and $p<0.05$, respectively). Asians had the lowest probability of being diagnosed with PTSD, compared to the other racial groups ($p<0.01$). Race was not a significant predictor of bipolar disorder.

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 25. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Marine officer population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.010*** | -0.0000 |
| | (0.002) | (0.001) |
| ***Service Characteristics (Combat Arms MOSs and W1 to W5 are the reference groups)*** | | |
| Combat Service | 0.001 | 0.0017 |
| | (0.002) | (0.002) |
| Service Support | -0.000 | 0.0004 |
| | (0.002) | (0.001) |
| Aviation | -0.007*** | -0.0001 |
| | (0.001) | (0.001) |
| Other MOS | -0.009*** | 0.0006 |
| | (0.002) | (0.002) |
| O1 to O2 | 0.004 | 0.0021 |
| | (0.002) | (0.001) |
| O3 | -0.002 | 0.0014 |
| | (0.002) | (0.001) |
| O4 | -0.007*** | 0.0021 |
| | (0.001) | (0.002) |
| O5 | -0.008*** | 0.0009 |
| | (0.002) | (0.002) |
| O6 to O10 | -0.006* | - |
| | (0.003) | - |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.014*** | 0.0054** |
| | (0.004) | (0.002) |
| Black | -0.002 | -0.0006 |
| | (0.002) | (0.001) |
| Hispanic | 0.003 | - |
| | (0.004) | - |
| Asian | -0.010*** | -0.0009 |
| | (0.002) | (0.002) |
| Other Race | 0.003 | 0.0007 |
| | (0.003) | (0.001) |
| Married | 0.002 | -0.0000 |
| | (0.001) | (0.001) |
| Age | 0.001*** | -0.0000 |
| | (0.000) | (0.000) |
| Missing age indicator | -0.007*** | -0.0022*** |
| | (0.003) | (0.001) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | -0.003* | -0.0006 |
| | (0.002) | (0.001) |
| CY2002 | -0.004* | -0.0021*** |
| | (0.002) | (0.001) |
| CY2003 | -0.005** | -0.0014* |
| | (0.002) | (0.001) |
| CY2004 | -0.004 | -0.0011 |
| | (0.002) | (0.001) |
| CY2005 | -0.006** | -0.0021*** |
| | (0.002) | (0.001) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| CY2006 | -0.009*** | -0.0009 |
| | (0.002) | (0.001) |
| CY2007 | -0.009*** | -0.0015 |
| | (0.002) | (0.001) |
| CY2008 | - | - |
| | - | - |
| Observed Probability | 0.015 | 0.0031 |
| Predicted Probability | 0.011 | 0.0025 |
| Observations | 25,317 | 23,570 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 26 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 25 are reproduced for comparison purposes.

Model 2 showed that deployment to Afghanistan, Iraq or another known OEF/OIF country increased the probability of being diagnosed with PTSD, compared to non-deployed population (all $p$<0.01).

Model 4 indicated the probability of being diagnosed with PTSD increased by 0.5 of one percentage point for Marine officers with 120 to 180 days of deployment, compared to those with fewer than 120 days ($p$<0.1).

Model 8 showed that the probability of being diagnosed with PTSD decreased by 0.7 of one percentage point if the deployed Marine officer was female, compared to male counterparts ($p$<0.01).

Model 3 suggested that there was no statistical significant relationship between having multiple deployments to OEF/OIF missions and the probability of being diagnosed with PTSD. The difference in deployment effects between the two periods in general as well as for all locations was not statistically significant, as shown in Models 5 and 6. Model 7 also showed that the interaction effect between deployment in OEF/OIF missions and non-combat arms MOSs was not statistically significant.

### 2. Bipolar Disorder

Table 27 presents the marginal effects of key variables of interests on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 25 are reproduced for comparison purposes.

Results of all eight models showed that none of the deployment-related variables of interest were associated with the probability of being diagnosed with bipolar disorder for Marine officers.

Table 26. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Marine officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.010*** | - | - | - | - | - | 0.011*** | 0.011*** |
| | (0.002) | | | | | | (0.003) | (0.002) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.011*** | - | - | - |
| | | | | | (0.002) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.004 | - | - | - |
| | | | | | (0.005) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.009*** | 0.010*** | 0.006* | - | - | - | - |
| | | (0.003) | (0.004) | (0.003) | | | | |
| Ever deployed to Iraq | - | 0.009*** | 0.010*** | 0.007*** | - | - | - | - |
| | | (0.002) | (0.003) | (0.002) | | | | |
| Ever deployed to an unknown/classified country | - | 0.005 | 0.006 | 0.003 | - | - | - | - |
| | | (0.005) | (0.005) | (0.004) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.009*** | 0.009*** | 0.006*** | - | - | - | - |
| | | (0.002) | (0.002) | (0.002) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.002 | - | - | - | - | - |
| | | | (0.002) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.005* | - | - | - | - |
| | | | | (0.003) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.003 | - | - | - | - |
| | | | | (0.002) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.009*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.005 | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.012) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.010*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.002 | - | - |
| | | | | | | (0.004) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | 0.005 | - | - |
| | | | | | | (0.005) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.008 | - | - |
| | | | | | | (0.021) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.009*** | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.005 | - | - |
| | | | | | | (0.008) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.002 | - |
| | | | | | | | (0.003) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.007*** |
| | | | | | | | | (0.002) |
| Observed Probability | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| Predicted Probability | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| Observations | 25,317 | 25,317 | 25,317 | 25,317 | 25,317 | 25,317 | 25,317 | 25,317 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 27. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Marine officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0000<br>(0.001) | - | - | - | - | - | 0.0000<br>(0.001) | -0.0002<br>(0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0001<br>(0.001) | - | - | - |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.0006<br>(0.002) | - | - | - |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.0004<br>(0.001) | 0.0007<br>(0.001) | 0.0002<br>(0.001) | - | - | - | - |
| Ever deployed to Iraq | - | 0.0010<br>(0.001) | 0.0014<br>(0.001) | 0.0009<br>(0.001) | - | - | - | - |
| Ever deployed to an unknown/classified country | - | 0.0011<br>(0.002) | 0.0015<br>(0.002) | 0.0010<br>(0.002) | - | - | - | - |
| Ever deployed to another OEF/OIF country | - | -0.0003<br>(0.001) | -0.0000<br>(0.001) | -0.0004<br>(0.001) | - | - | - | - |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0008<br>(0.001) | - | - | - | - | - |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.0000<br>(0.001) | - | - | - | - |
| Long duration (more than 180 days) | - | - | - | 0.0003<br>(0.001) | - | - | - | - |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.0008<br>(0.001) | - | - |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | - | - | - |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.0009 | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.0005 | - | - |
| | | | | | | (0.002) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0002 | - | - |
| | | | | | | (0.002) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.0421 | - | - |
| | | | | | | (0.042) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0003 | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0006 | - | - |
| | | | | | | (0.002) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.0000 | - |
| | | | | | | | (0.002) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | 0.0013 |
| | | | | | | | | (0.003) |
| Observed Probability | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| Predicted Probability | 0.003 | 0.002 | 0.002 | 0.002 | 0.003 | 0.002 | 0.003 | 0.003 |
| Observations | 23,570 | 23,570 | 23,570 | 23,570 | 23,570 | 23,308 | 23,570 | 23,570 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## F. NAVY ENLISTED POPULATION RESULTS

Table 28 presents the complete results of Model 1 for both PTSD and bipolar disorder among Navy enlisted personnel. The key variable of interest was whether the service member had been sent for deployment in OEF/OIF missions within the observation window.

For a reference sailor (single white male in E1 to E2 rank, serving in combat arms specialty field), his probability of being diagnosed with PTSD increased by 0.4 of one percentage point if deployed, compared to those not deployed ($p<0.01$). On the other hand, deployment in OEF/OIF missions was associated with a lower probability of being diagnosed with bipolar disorder by 0.39 of one percentage point ($p<0.01$).

The probabilities of being diagnosed with PTSD or bipolar disorder were generally higher if an average Navy enlisted personnel was sent for a shore-based deployment, compared to ship-based deployment. A sailor's probabilities of being diagnosed with PTSD or bipolar disorder increased by 0.2 and 0.1 of one percentage point, respectively, if deployed on shore ($p<0.01$ and $p<0.05$, respectively).

Unlike the results seen with the Army, being in service support, medical or other MOSs generally increased the probability of being diagnosed with PTSD compared to combat arms. As for bipolar disorder, Navy enlisted personnel in medical specialty fields had a higher probability of being diagnosed with the condition, compared to all other specialty fields ($p<0.01$).

Being in middle pay grades (E3 to E5) generally increased an average Navy enlisted personnel's probability of being diagnosed with either mental health disorder, compared to junior pay grades (E1 to E2) ($p<0.01$ for PTSD and $p<0.1$ for bipolar disorder). The opposite effects were observed for those in senior pay grades (E6 to E9) (both $p<0.01$).

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males (1.8 and 0.8 of one percentage point, respectively,

both *p<0.01)*. Hispanics and personnel in "other race" had higher probabilities of being diagnosed with PTSD, compared to whites ($p$<0.1 and $p$<0.01, respectively). Blacks and Asians generally had lower probabilities of being diagnosed with PTSD, as compared to whites (both $p$<0.01). As for bipolar disorder, whites had higher probability of being diagnosed with the condition, compared to all other races ($p$<0.01). Married personnel had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to non-married personnel (0.6 and 0.16 of one percentage point, respectively, both $p$<0.01).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 28. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Navy enlisted population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.004*** | -0.0039*** |
| | (0.000) | (0.000) |
| Shore-based Deployment | 0.002*** | 0.0010** |
| | (0.001) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and E1 to E2 are the reference groups)*** | | |
| Combat Service | -0.004*** | -0.0006 |
| | (0.001) | (0.001) |
| Service Support | 0.008*** | -0.0003 |
| | (0.002) | (0.001) |
| Aviation | -0.002 | -0.0010 |
| | (0.001) | (0.001) |
| Medical | 0.070*** | 0.0028*** |
| | (0.004) | (0.001) |
| Other MOS | 0.005*** | 0.0004 |
| | (0.001) | (0.001) |
| E3 to E5 | 0.001*** | 0.0004* |
| | (0.000) | (0.000) |
| E6 to E9 | -0.007*** | -0.0025*** |
| | (0.001) | (0.000) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.018*** | 0.0080*** |
| | (0.001) | (0.000) |
| Black | -0.004*** | -0.0038*** |
| | (0.000) | (0.000) |
| Hispanic | 0.001* | -0.0030*** |
| | (0.001) | (0.000) |
| Asian | -0.003*** | -0.0046*** |
| | (0.001) | (0.000) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| Other Race | 0.002*** | -0.0009*** |
| | (0.001) | (0.000) |
| Married | 0.006*** | 0.0016*** |
| | (0.000) | (0.000) |
| Age | 0.000 | -0.0001*** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.013*** | -0.0043*** |
| | (0.000) | (0.000) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | 0.002*** | 0.0008** |
| | (0.001) | (0.000) |
| CY2002 | 0.002*** | 0.0008* |
| | (0.001) | (0.000) |
| CY2003 | 0.003*** | -0.0003 |
| | (0.001) | (0.000) |
| CY2004 | 0.003*** | -0.0001 |
| | (0.001) | (0.000) |
| CY2005 | 0.002*** | -0.0003 |
| | (0.001) | (0.000) |
| CY2006 | 0.000 | 0.0005 |
| | (0.001) | (0.000) |
| CY2007 | -0.002*** | -0.0003 |
| | (0.001) | (0.000) |
| CY2008 | -0.003*** | -0.0000 |
| | (0.001) | (0.001) |
| Observed Probability | 0.019 | 0.0077 |
| Predicted Probability | 0.016 | 0.0066 |
| Observations | 575,986 | 575,986 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 29 presents the marginal effects of key variables of interests on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 28 are reproduced for comparison purposes.

Model 2 results indicated that deployment to Iraq or another OEF/OIF country increased the probability of being diagnosed with PTSD, compared to those not deployed (7.2 and 1.2 percentage points, respectively, both $p$<0.01). Deployment to an unknown/classified country decreased the probability of being diagnosed with PTSD by 0.5 of one percentage point ($p$<0.01). The location coefficient comparisons were statistically significantly different ($p$<0.01).

Model 3 showed that having multiple deployments to OEF/OIF missions increased an average Navy enlisted personnel's probability of being diagnosed with PTSD by 0.1 of one percentage point, compared to those with a single deployment in OEF/OIF missions ($p<0.05$).

Model 4 showed that deployment duration was not a significant predictor of the probability of being diagnosed with PTSD. Model 5 also indicated that the difference in the coefficient estimates between the two periods was not statistically significant.

There were mixed results regarding differential deployment effects by period when the authors analyzed each location category separately. Model 6 suggested that deployment in OEF/OIF missions had greater effects in the earlier period (CY2005 and prior) for all locations ($p<0.01$), except for Afghanistan.

Model 7 showed the deployment effect was greater for those sailors in non-combat arms specialty fields, compared to those in combat arms specialty fields, by 0.9 of one percentage point ($p<0.01$).

Results of Model 8 suggested that the probability of being diagnosed with PTSD was lower by 0.8 of one percentage point if a deployed Navy enlisted personnel was female, compared to male counterparts ($p<0.01$).

### 2. Bipolar Disorder

Table 30 presents the marginal effects of key variables of interests on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 28 are reproduced for comparison purposes.

Model 2 showed that the deployment effect varied somewhat across locations, but all coefficient estimates were of very small practical magnitude. No significant difference in the bipolar disorder rates between those with a single and multiple deployments was found, as shown in Model 3. From Model 4, Navy enlisted personnel with 120 to 180 days, and more than 180 days of deployment, were associated with reduced probability of being diagnosed with bipolar

disorder, as compared to those deployed less than 120 days (0.11 and 0.22 of one percentage point, $p<0.05$ and $p<0.01$, respectively).

Model 5 showed that the probability of being diagnosed with bipolar disorder was associated with a decrease of 0.24 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 0.42 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2006 and after (both $p<0.01$). The differential effect between the two periods was statistically significant ($p<0.01$).

Results of Model 6 showed having a first deployment to Iraq, an unknown/classified country or another OEF/OIF country occurred in CY2006 and after was associated with a lower probability of being diagnosed with bipolar disorder, compared to CY2005 and prior ($p<0.01$ for Iraq and an unknown/classified country, $p<0.05$ for another OEF/OIF country).

Model 7 showed that being deployed and from non-combat arms MOSs was associated with a lower probability of being diagnosed with bipolar disorder, by 0.21 of one percentage point, compared to those deployed and from combat arms MOSs ($p<0.1$). Lastly, Model 8 showed no significant association between the interaction of gender and deployment in OEF/OIF missions and the probability of being diagnosed with bipolar disorder.

Table 29. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Navy enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.004*** | - | - | - | - | - | -0.004** | 0.007*** |
| | (0.000) | | | | | | (0.002) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.004*** | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.005*** | - | - | - |
| | | | | | (0.001) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.000 | -0.000 | 0.000 | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.072*** | 0.071*** | 0.072*** | - | - | - | - |
| | | (0.002) | (0.003) | (0.003) | | | | |
| Ever deployed to an unknown/classified country | - | -0.005*** | -0.005*** | -0.005*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.012*** | 0.012*** | 0.012*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | 0.001** | - | - | - | - | |
| | | | | | | | | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.000 | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.000 | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.003*** | - | - |
| | | | | | | (0.001) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.037*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.097*** | - | - |
| | | | | | | (0.004) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.050*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.003*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.006*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.014*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.002* | - | - |
| | | | | | | (0.001) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.009*** | - |
| | | | | | | | (0.002) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.008*** |
| | | | | | | | | (0.000) |
| Observed Probability | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| Predicted Probability | 0.016 | 0.014 | 0.014 | 0.014 | 0.016 | 0.014 | 0.016 | 0.015 |
| Observations | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 30. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Navy enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0039*** (0.000) | - | - | - | - | - | -0.0019 (0.001) | -0.0040*** (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0024*** (0.000) | - | - | - |
| First deployment occurred in CY2006 and after | - | - | - | - | -0.0042*** (0.000) | - | - | - |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0028*** (0.000) | -0.0029*** (0.000) | -0.0018*** (0.000) | - | - | - | - |
| Ever deployed to Iraq | - | -0.0010* (0.001) | -0.0010* (0.001) | 0.0003 (0.001) | - | - | - | - |
| Ever deployed to an unknown/classified country | - | -0.0029*** (0.000) | -0.0030*** (0.000) | -0.0019*** (0.000) | - | - | - | - |
| Ever deployed to another OEF/OIF country | - | -0.0021*** (0.000) | -0.0022*** (0.000) | -0.0012*** (0.000) | - | - | - | - |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | 0.0002 (0.000) | - | - | - | - | - |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.0011** (0.000) | - | - | - | - |
| Long duration (more than 180 days) | - | - | - | -0.0022*** (0.000) | - | - | - | - |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0021*** (0.000) | - | - |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | -0.0032*** (0.001) | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.0019 | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | -0.0024*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0017*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.0041*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0012** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0028*** | - | - |
| | | | | | | (0.000) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.0021* | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | 0.0004 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| Predicted Probability | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| Observations | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 | 575,986 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## G. NAVY OFFICER POPULATION RESULTS

Table 31 presents the complete results of Model 1 for both PTSD and bipolar disorder among Navy officers. The key variable of interest was whether the Navy officer had been sent for deployment in OEF/OIF missions within the observation window.

There was a small but statistically significant effect of deployment in OEF/OIF missions on PTSD. The probability of being diagnosed with PTSD was higher by 0.3 of one percentage point for a reference Navy Officer (single white male warrant officer who served in a combat arms specialty field) if deployed, compared to those not deployed ($p$<0.01). The probability of being diagnosed with bipolar disorder was not associated with deployment in OEF/OIF missions.

Whether a Navy officer was deployed on shore or in ship had no effect on the probabilities of being diagnosed with the two mental health conditions. However, being in a combat arms specialty field, and middle and senior pay grades (O4 to O10) generally lowered the probabilities for both conditions (both $p$<0.01).

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males, by 1.1 and 0.59 of one percentage point, respectively (both $p$<0.01). In terms of race, only the coefficient estimate for Asians was statistically significant ($p$<0.01), at 0.20 of one percentage point lower than whites. Married personnel had higher probabilities of being diagnosed with PTSD or bipolar disorder, by 0.2 and 0.11 of one percentage point, respectively, compared to non-married personnel ($p$<0.01 and $p$<0.05, respectively).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 31. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Navy officer population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.003** | 0.0002 |
| | (0.001) | (0.001) |
| Shore-based Deployment | 0.000 | -0.0012 |
| | (0.001) | (0.001) |
| ***Service Characteristics (Combat Arms MOSs and W1 to W5 are the reference groups)*** | | |
| Combat Service | 0.776*** | 0.7613*** |
| | (0.094) | (0.190) |
| Service Support | 0.021*** | 0.0113*** |
| | (0.002) | (0.002) |
| Aviation | 0.992*** | 0.9946*** |
| | (0.003) | (0.000) |
| Medical | 0.984*** | - |
| | (0.000) | - |
| Other MOS | 0.740*** | 0.7767*** |
| | (0.114) | (0.190) |
| O1 to O2 | 0.001 | 0.0011 |
| | (0.001) | (0.001) |
| O3 | -0.001 | -0.0005 |
| | (0.001) | (0.001) |
| O4 | -0.006*** | -0.0022*** |
| | (0.001) | (0.001) |
| O5 | -0.007*** | -0.0022*** |
| | (0.001) | (0.001) |
| O6 to O10 | -0.008*** | -0.0032*** |
| | (0.000) | (0.000) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.011*** | 0.0059*** |
| | (0.001) | (0.001) |
| Black | 0.001 | 0.0001 |
| | (0.001) | (0.001) |
| Hispanic | 0.002 | 0.0003 |
| | (0.002) | (0.001) |
| Asian | 0.000 | -0.0020*** |
| | (0.001) | (0.001) |
| Other Race | -0.001 | -0.0006 |
| | (0.001) | (0.001) |
| Married | 0.002*** | 0.0011** |
| | (0.001) | (0.000) |
| Age | 0.001*** | 0.0001** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.006*** | -0.0011 |
| | (0.001) | (0.001) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | -0.000 | -0.0005 |
| | (0.001) | (0.001) |
| CY2002 | -0.000 | -0.0019*** |
| | (0.001) | (0.001) |
| CY2003 | -0.000 | -0.0012 |
| | (0.001) | (0.001) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| CY2004 | -0.002 | -0.0008 |
| | (0.001) | (0.001) |
| CY2005 | -0.001 | -0.0009 |
| | (0.001) | (0.001) |
| CY2006 | -0.002** | -0.0017** |
| | (0.001) | (0.001) |
| CY2007 | -0.005*** | -0.0027*** |
| | (0.001) | (0.001) |
| CY2008 | -0.003* | -0.0035*** |
| | (0.001) | (0.000) |
| Observed Probability | 0.010 | 0.0045 |
| Predicted Probability | 0.007 | 0.0035 |
| Observations | 80,690 | 80,647 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 32 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 31 are reproduced for comparison purposes.

Model 2 showed that deployment to Iraq or another OEF/OIF country increased the probability of being diagnosed with PTSD by 1.8 percentage points, compared to non-deployed ($p$<0.01). Deployment to Afghanistan decreased the probability of being diagnosed with PTSD by 0.2 of one percentage point ($p$<0.01). Most of the pairwise location coefficient comparisons were significant ($p$<0.01), except for Afghanistan and an unknown/classified country.

Results of Model 3 showed that having multiple deployments to OEF/OIF missions was associated with a lower probability of being diagnosed with PTSD, by 0.2 of one percentage point, compared to those with a single deployment in OEF/OIF missions ($p$<0.05).

From Model 4, an average Navy officer's probability of being diagnosed with PTSD increased by 0.3 of one percentage point when deployed for 120 to 180 days, compared to one who was deployed for fewer than 120 days ($p$<0.1).

Results of Model 7 showed that the probability of being diagnosed with PTSD significantly decreased by 0.2 of one percentage point if the deployed Navy officer was from a non-combat arms MOS, compared to those deployed and from combat arms MOSs ($p$<0.01).

Models 5 and 6 showed no statistically significant differential deployment effects, either in general or by locations, between the two periods (CY2005 and before, and CY2006 and after). Likewise, Model 8 showed no significant interactive effect between gender and deployment in OEF/OIF missions.

### 2. Bipolar Disorder

Table 33 presents the marginal effects of key variables of interest on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 31 are reproduced for comparison purposes.

Model 2 showed that deployment to Afghanistan was associated with reduced probability of being diagnosed with bipolar disorder by 0.17 of one percentage point, compared to non-deployed ($p$<0.05).

Model 3 showed that an average Navy officer with multiple deployments to OEF/OIF missions was associated with a lower probability of being diagnosed with bipolar disorder by 0.18 of one percentage point, compared to those with a single deployment in OEF/OIF missions ($p$<0.05).

Results of Model 7 showed that the interactive effect of being deployed and from non-combat arms MOSs was associated with a lower probability of being diagnosed with bipolar disorder, by 0.47 of one percentage point, compared to those deployed and from combat arms MOSs ($p$<0.01).

Model 8 showed that the probability of being diagnosed with bipolar disorder was associated with a decrease of 0.15 of one percentage point if a deployed Navy officer was female, compared to a deployed male officer ($p$<0.05).

Model 4 indicated that the number of days of deployment in OEF/OIF missions had no significant effect on the probability of being diagnosed with

bipolar disorder. The probability of being diagnosed with bipolar disorder was also not affected by the time of deployment in OEF/OIF missions, as shown in Model 5. Likewise for Model 6, there were no statistical differences between the two periods for all four locations.

Table 32. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Navy officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.003** | - | - | - | - | - | 0.006*** | 0.003** |
| | (0.001) | | | | | | (0.002) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.002 | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.004 | - | - | - |
| | | | | | (0.003) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.002* | -0.001 | -0.003** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.018*** | 0.021*** | 0.016*** | - | - | - | - |
| | | (0.004) | (0.005) | (0.004) | | | | |
| Ever deployed to an unknown/classified country | - | -0.002 | -0.001 | -0.002** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.005*** | 0.007*** | 0.004** | - | - | - | - |
| | | (0.002) | (0.002) | (0.002) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.002** | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.003* | - | - | - | - |
| | | | | (0.002) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.002 | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.002* | - | - |
| | | | | | | (0.001) | | |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.005 | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.006) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.022*** | - | - |
| | | | | | | (0.006) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.011** | - | - |
| | | | | | | (0.006) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.001 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.004** | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.006*** | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.002 | - | - |
| | | | | | | (0.003) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.002*** | - |
| | | | | | | | (0.000) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.001 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Predicted Probability | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| Observations | 80,690 | 80,690 | 80,690 | 80,690 | 80,690 | 80,690 | 80,690 | 80,690 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 33. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Navy officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.0002<br>(0.001) | - | - | - | - | - | 0.0099***<br>(0.002) | 0.0007<br>(0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.0003<br>(0.001) | - | - | - |
| First deployment occurred in CY2006 and after | - | - | - | - | -0.0002<br>(0.001) | - | - | - |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0017**<br>(0.001) | -0.0010<br>(0.001) | -0.0013<br>(0.001) | - | - | - | - |
| Ever deployed to Iraq | - | 0.0017<br>(0.002) | 0.0026<br>(0.002) | 0.0025<br>(0.002) | - | - | - | - |
| Ever deployed to an unknown/classified country | - | -0.0005<br>(0.001) | 0.0001<br>(0.001) | -0.0002<br>(0.001) | - | - | - | - |
| Ever deployed to another OEF/OIF country | - | 0.0002<br>(0.001) | 0.0011<br>(0.001) | 0.0006<br>(0.001) | - | - | - | - |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0018**<br>(0.001) | - | - | - | - | - |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.0002<br>(0.001) | - | - | - | - |
| Long duration (more than 180 days) | - | - | - | -0.0011<br>(0.001) | - | - | - | - |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0016*<br>(0.001) | - | - |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | - | - | - |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.0018 | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.003) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.0016 | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0008 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | 0.0012 | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.0005 | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0015 | - | - |
| | | | | | | (0.002) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.0047*** | - |
| | | | | | | | (0.000) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.0015** |
| | | | | | | | | (0.001) |
| Observed Probability | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| Predicted Probability | 0.004 | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 |
| Observations | 80,647 | 80,647 | 80,647 | 80,647 | 80,647 | 80,344 | 80,647 | 80,647 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## H. AIR FORCE ENLISTED POPULATION RESULTS

Table 34 presents the complete results of Model 1 for both PTSD and bipolar disorder among Air Force enlisted personnel. The key variable of interest was whether the service member had been sent for deployment in OEF/OIF missions within the observation window.

The probabilities of being diagnosed with PTSD or bipolar disorder were significantly dependent on whether an Air Force enlisted personnel was sent for deployment in OEF/OIF missions ($p<0.01$). A reference Air Force enlisted personnel's (single white male in E1 to E2 rank, serving in a combat arms specialty field) probability of being diagnosed with PTSD increased by 0.8 of one percentage point if deployed, compared to those not deployed ($p<0.01$). On the other hand, the probability of being diagnosed with bipolar disorder was lowered by 0.25 of one percentage point among the deployed population, compared to those not deployed ($p<0.01$).

Being in a combat arms specialty fields was associated with a lower probability of being diagnosed with PTSD, compared to other specialty fields, except medical ($p<0.01$). Being in middle pay grades (E3 to E5) generally increased an average Air Force enlisted personnel's probability of being diagnosed with either mental health disorder, compared to being in junior pay grades (E1 to E2) ($p<0.01$ for PTSD and $p<0.1$ for bipolar disorder). Being in senior pay grades (E6 to E9) generally decreased his probability, compared to being in junior pay grades (E1 to E2) (both $p<0.01$).

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, by 1.9 and 0.76 of one percentage point higher, respectively, compared to males, (both $p<0.01$). Hispanics had higher probability of being diagnosed with PTSD, compared to whites ($p<0.05$). Blacks and Asians had lower probabilities of being diagnosed with the same condition, compared to whites (both $p<0.01$). As for bipolar disorder, whites had higher probability of being diagnosed with the condition than the other race minority groups ($p<0.01$).

Married personnel had higher probability of being diagnosed with PTSD (0.5 of one percentage point) and bipolar disorder (0.12 of one percentage point), compared to non-married personnel (both $p<0.01$).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 34. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Air Force enlisted population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.008*** | -0.0025*** |
| | (0.000) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and E1 to E2 are the reference groups)*** | | |
| Combat Service | 0.002*** | 0.0006 |
| | (0.001) | (0.000) |
| Service Support | 0.004*** | 0.0004 |
| | (0.001) | (0.000) |
| Medical | 0.002 | 0.0014 |
| | (0.002) | (0.001) |
| Other MOS | 0.011*** | 0.0002 |
| | (0.001) | (0.000) |
| E3 to E5 | 0.002*** | 0.0005* |
| | (0.000) | (0.000) |
| E6 to E9 | -0.008*** | -0.0033*** |
| | (0.001) | (0.000) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.019*** | 0.0076*** |
| | (0.001) | (0.000) |
| Black | -0.004*** | -0.0035*** |
| | (0.000) | (0.000) |
| Hispanic | 0.002** | -0.0032*** |
| | (0.001) | (0.000) |
| Asian | -0.005*** | -0.0036*** |
| | (0.001) | (0.000) |
| Other Race | -0.001 | -0.0030*** |
| | (0.001) | (0.000) |
| Married | 0.005*** | 0.0012*** |
| | (0.000) | (0.000) |
| Age | -0.000*** | -0.0002*** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.013*** | -0.0044*** |
| | (0.000) | (0.000) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | -0.001 | 0.0004 |
| | (0.001) | (0.000) |
| CY2002 | -0.001** | -0.0007* |
| | (0.001) | (0.000) |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| CY2003 | -0.002*** | -0.0011*** |
| | (0.001) | (0.000) |
| CY2004 | -0.002*** | -0.0018*** |
| | (0.001) | (0.000) |
| CY2005 | -0.001 | -0.0023*** |
| | (0.001) | (0.000) |
| CY2006 | -0.003*** | -0.0022*** |
| | (0.001) | (0.000) |
| CY2007 | -0.005*** | -0.0024*** |
| | (0.001) | (0.000) |
| CY2008 | -0.007*** | -0.0033*** |
| | (0.001) | (0.001) |
| Observed Probability | 0.019 | 0.0082 |
| Predicted Probability | 0.016 | 0.0071 |
| Observations | 496,997 | 496,997 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 35 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 34 are reproduced for comparison purposes.

Model 2 showed that deployment to Afghanistan, Iraq or another known OEF/OIF country increased the probability of being diagnosed with PTSD, compared to non-deployed (all $p$<0.01). The magnitude of increase was the highest at 2.3 percentage points if deployed to Iraq, followed by 0.5 of one percentage point if deployed to Afghanistan, and 0.4 of one percentage point if deployed to another known OEF/OIF country.

Results of Model 3 showed that there was no association between frequency of deployments and the probability of being diagnosed with PTSD. From Model 4, the probability of being diagnosed with PTSD increased by 0.1 of one percentage point for Air Force enlisted personnel with 120 to 180 days of deployment in OEF/OIF missions, and by 0.7 of one percentage point if deployed for more than 180 days, compared to those with fewer than 120 days ($p$<0.05 and $p$<0.01, respectively).

The probability of being diagnosed with PTSD increased by 0.8 of one percentage point for an average Air Force enlisted personnel whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and 1.2 percentage points whose first deployment in OEF/OIF missions occurred in CY2006 and after, as shown in Model 5 (both $p<0.01$). The coefficient estimates for the two periods were statistically different ($p<0.01$).

Model 6 showed that Air Force enlisted personnel who were first deployed to Afghanistan in CY2005 and prior had lower probability of being diagnosed with PTSD, than those who were first deployed to the same location in CY2006 and after ($p<0.01$). The opposite was true for Iraq ($p<0.01$).

The results of Model 7 showed that the probability of being diagnosed with PTSD significantly increased by 0.4 of one percentage point if the deployed Air Force enlisted personnel was from a non-combat arms MOS, compared to those deployed and from combat arms MOSs ($p<0.01$).

Model 8 showed that the probability of being diagnosed with PTSD decreased by 0.6 of one percentage point if the deployed Air Force enlisted personnel was female, compared to male counterparts ($p<0.01$).

### 2. Bipolar Disorder

Table 36 presents the marginal effects of key variables of interest on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 34 are reproduced for comparison purposes.

As shown in Model 2, deployment to any OEF/OIF location (Afghanistan, Iraq, an unknown/classified country or another OEF/OIF country) was associated with a lower probability of being diagnosed with bipolar disorder, compared to non-deployed (by 0.22, 0.24, 0.25, and 0.15 of one percentage point, respectively, all $p<0.01$). All pairwise location coefficient comparison were significant except between Afghanistan and another OEF/OIF country ($p<0.01$).

Model 4 showed that a higher number of days deployed was associated with a reduced probability of being diagnosed with bipolar disorder. The probability was decreased by 0.09 of one percentage point for Air Force enlisted personnel with 120 to 180 days of deployment in OEF/OIF missions, and by 0.17 percentage point if deployed more than 180 days, compared to those with fewer than 120 days ($p<0.05$ and $p<0.01$, respectively).

Model 5 indicated that the probability of being diagnosed with bipolar disorder decreased by 0.21 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2005 and prior, and by 0.34 of one percentage point for those whose first deployment in OEF/OIF missions occurred in CY2006 and after (both $p<0.01$). The coefficient estimates for both periods were found to be statistically different ($p<0.01$). Model 6 also showed that statistical differences were found between the two periods for first deployment to Afghanistan or another OEF/OIF country ($p<0.01$ and $p<0.05$, respectively).

Model 3 showed that there was no association between deployment frequency and the probability of being diagnosed with bipolar disorder for Air Force enlisted personnel. Models 7 and 8 also suggested that there were no association between the interactive effects of deployment in OEF/OIF missions and MOS, and deployment in OEF/OIF missions and female with the probability of being diagnosed with bipolar disorder.

Table 35. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Air Force enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.008*** | - | - | - | - | - | 0.004*** | 0.011*** |
| | (0.000) | | | | | | (0.001) | (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.008*** | - | - | - |
| | | | | | (0.000) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.012*** | - | - | - |
| | | | | | (0.001) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.005*** | 0.004*** | 0.002*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.023*** | 0.023*** | 0.019*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to an unknown/classified country | - | -0.001 | -0.001 | -0.002*** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.004*** | 0.004*** | 0.002*** | - | - | - | - |
| | | (0.000) | (0.000) | (0.000) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | 0.001 | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.001** | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.007*** | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | 0.002** | - | - |
| | | | | | | (0.001) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.013*** | - | - |
| | | | | | | (0.002) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.027*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.020*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.000 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.002 | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.004*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | 0.005*** | - | - |
| | | | | | | (0.001) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.004*** | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.006*** |
| | | | | | | | | (0.001) |
| Observed Probability | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 | 0.019 |
| Predicted Probability | 0.016 | 0.015 | 0.015 | 0.015 | 0.016 | 0.015 | 0.016 | 0.015 |
| Observations | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 36. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Air Force enlisted population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | -0.0025*** (0.000) | - | - | - | - | - | -0.0029*** (0.001) | -0.0027*** (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0021*** (0.000) | - | - | - |
| First deployment occurred in CY2006 and after | - | - | - | - | -0.0034*** (0.000) | - | - | - |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0022*** (0.000) | -0.0021*** (0.000) | -0.0018*** (0.000) | - | - | - | - |
| Ever deployed to Iraq | - | -0.0024*** (0.000) | -0.0022*** (0.000) | -0.0018*** (0.000) | - | - | - | - |
| Ever deployed to an unknown/classified country | - | -0.0025*** (0.000) | -0.0023*** (0.001) | -0.0022*** (0.000) | - | - | - | - |
| Ever deployed to another OEF/OIF country | - | -0.0015*** (0.000) | -0.0013*** (0.000) | -0.0009*** (0.000) | - | - | - | - |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0007 (0.000) | - | - | - | - | - |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | -0.0009** (0.000) | - | - | - | - |
| Long duration (more than 180 days) | - | - | - | -0.0017*** (0.000) | - | - | - | - |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0014*** (0.000) | - | - |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | -0.0048*** (0.001) | - | - |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | -0.0023*** | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.000) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | -0.0025*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0026*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.0021** | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0013*** | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.0025*** | - | - |
| | | | | | | (0.000) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | 0.0004 | - |
| | | | | | | | (0.001) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | 0.0007 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| Predicted Probability | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| Observations | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 | 496,997 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## I. AIR FORCE OFFICER POPULATION RESULTS

Table 37 presents the complete results of Model 1 for both PTSD and bipolar disorder among Air Force officers. The key variable of interest was whether the service member was sent for deployment in OEF/OIF missions within the observation window.

A reference Air Force officer's (single white male officer in O1 or O2 pay grade, and served in a combat arms specialty field) probability of being diagnosed with PTSD increased by 0.4 of one percentage point if deployed, compared to those not deployed ($p<0.01$). On the other hand, deployment in OEF/OIF missions was associated with a lower probability of being diagnosed with bipolar disorder, by 0.13 of one percentage point, compared to those not deployed ($p<0.01$).

Being in a combat arms specialty field, and middle or senior pay grades (O4 to O10) were generally associated with a reduced probability of being diagnosed with either mental health disorder (both $p<0.01$).

In terms of demographics, females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males, (by 1.3 and 0.37 of one percentage point, respectively, both $p<0.01$). Hispanics and officers of "other race" had higher probabilities of being diagnosed with PTSD by 1.0 and 0.2 of one percentage point, respectively, compared to whites ($p<0.01$ and $p<0.05$, respectively). Married personnel had higher probability by 0.1 of one percentage point of being diagnosed with PTSD, compared to non-married personnel ($p<0.05$).

The next two sections provide regression results of all models separately for PTSD and bipolar disorder.

Table 37. Model 1: Marginal effect of deployment on probability of being diagnosed with PTSD and bipolar disorder (Air Force officer population)

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| ***Deployment Characteristics*** | | |
| Deployed in OEF/OIF missions | 0.004*** | -0.0013*** |
| | (0.001) | (0.000) |
| ***Service Characteristics (Combat Arms MOSs and O1 to O2 are the reference groups)*** | | |
| Combat Service | 0.980*** | 0.9660*** |
| | (0.014) | (0.030) |
| Service Support | - | - |
| | - | - |
| Medical | - | - |
| | - | - |
| Other MOS | 0.008*** | 0.0030*** |
| | (0.000) | (0.000) |
| O3 | -0.000 | 0.0002 |
| | (0.001) | (0.000) |
| O4 | -0.005*** | -0.0014*** |
| | (0.001) | (0.000) |
| O5 | -0.006*** | -0.0021*** |
| | (0.001) | (0.000) |
| O6 to O10 | -0.007*** | -0.0024*** |
| | (0.000) | (0.000) |
| ***Demographic Characteristics (Male, White, and non-married with no missing age information are the reference groups)*** | | |
| Female | 0.013*** | 0.0037*** |
| | (0.001) | (0.001) |
| Black | 0.002 | -0.0006 |
| | (0.001) | (0.001) |
| Hispanic | 0.010*** | -0.0009 |
| | (0.003) | (0.001) |
| Asian | -0.001 | -0.0005 |
| | (0.001) | (0.001) |
| Other Race | 0.002** | 0.0005 |
| | (0.001) | (0.001) |
| Married | 0.001** | -0.0001 |
| | (0.001) | (0.000) |
| Age | 0.000*** | 0.0001*** |
| | (0.000) | (0.000) |
| Missing age indicator | -0.007*** | -0.0019*** |
| | (0.001) | (0.000) |
| ***Calendar Year of Observation (CY2000 is the reference group)*** | | |
| CY2001 | 0.000 | -0.0005 |
| | (0.001) | (0.000) |
| CY2002 | -0.000 | -0.0003 |
| | (0.001) | (0.001) |
| CY2003 | -0.003*** | -0.0010** |
| | (0.001) | (0.001) |
| CY2004 | -0.001 | -0.0001 |

| Variable | PTSD | Bipolar Disorder |
|---|---|---|
| | (0.001) | (0.001) |
| CY2005 | -0.002 | -0.0015*** |
| | (0.001) | (0.001) |
| CY2006 | -0.001 | -0.0014** |
| | (0.001) | (0.001) |
| CY2007 | -0.003*** | -0.0019*** |
| | (0.001) | (0.000) |
| CY2008 | -0.003** | -0.0017*** |
| | (0.001) | (0.001) |
| Observed Probability | 0.010 | 0.0036 |
| Predicted Probability | 0.008 | 0.0029 |
| Observations | 108,575 | 108,575 |
| Standard errors in parentheses<br>*** $p$<0.01, ** $p$<0.05, * $p$<0.1 | | |

### 1. PTSD

Table 38 presents the marginal effects of key variables of interest on the probability of being diagnosed with PTSD. Results of Model 1 shown in the first column of Table 37 are included for comparison purposes.

Model 2 indicated that deployment to Afghanistan or Iraq increased the probability of being diagnosed with PTSD by 0.2 and 1.6 percentage points, respectively, compared to those not deployed ($p$<0.05 and $p$<0.01, respectively). Deployment to an unknown/classified country decreased the probability of being diagnosed with PTSD by 0.2 of one percentage point, compared to those not deployed ($p$<0.05). Pairwise location coefficient comparisons showed significant differences between Iraq and the other three locations ($p$<0.01), as well as between Afghanistan and an unknown/classified country ($p$<0.05).

In terms of deployment frequency, Model 3 showed that having multiple deployments in OEF/OIF missions decreased the probability of being diagnosed with PTSD by 0.2 of one percentage point, compared to an average Air Force officer with a single deployment in OEF/OIF missions ($p$<0.01). From Model 4, an average Air Force officer's probability of being diagnosed with PTSD decreased

by 0.3 of one percentage point when deployed for between 120 to 180 days, compared to those deployed for fewer than 120 days ($p$<0.05).

Model 5 showed that there was no significant difference between the coefficient estimates of the two deployment periods on the probability of being diagnosed with PTSD. However, Model 6 showed that an average Air Force officer's probability of being diagnosed with PTSD was higher when first deployed to Afghanistan in CY2006 and after, as compared to those whose first deployment to the same location occurred in CY2005 and prior ($p$<0.01).

Model 7 showed that the probability of being diagnosed with PTSD significantly decreased by 0.1 of one percentage point if a deployed Air Force officer was from a non-combat arms MOS, compared to those deployed and from combat arms MOSs ($p$<0.01).

Results of Model 8 suggested that the interaction effect between deployment in OEF/OIF missions and gender did not have a significant effect on the probability of being diagnosed with PTSD.

### 2. Bipolar Disorder

Table 39 presents the marginal effects of key variables of interest on the probability of being diagnosed with bipolar disorder. Results of Model 1 shown in the second column of Table 37 are reproduced for comparison purposes.

As shown in Model 2, deployment to Afghanistan, an unknown/classified country or another OEF/OIF country was associated with a reduced probability of being diagnosed with bipolar disorder by 0.09, 0.19 and 0.1 of one percentage point, respectively, compared to non-deployed ($p$<0.1, $p$<0.01 and $p$<0.01, respectively). The coefficient estimates of Iraq and an unknown/classified country were statistically different ($p$<0.05).

Results of Model 3 showed that OEF/OIF deployment frequency was not associated with the probability of being diagnosed with bipolar disorder for Air Force officers. Model 4 showed that being deployed for more than 180 days was

associated with the probability of being diagnosed with bipolar disorder. The probability was lowered by 0.11 of one percentage point when an average Air Force officer was deployed in OEF/OIF missions for more than 180 days, compared to those who were deployed for 180 days and less ($p<0.1$).

The results of Model 7 showed that the interactive effect of being deployed and from non-combat arms MOSs was associated with a lower probability of being diagnosed with bipolar disorder, by 0.23 of one percentage point, compared to those deployed and from combat arms MOSs ($p<0.01$).

Models 5 and 6 showed that there were no statistical differences between the coefficient effects of deployment in OEF/OIF missions in CY2005 and prior, and CY2006 and after, in general, as well as for all locations. Model 8 also showed that the interaction effect between deployment in OEF/OIF missions and female was not associated with the probability of being diagnosed with bipolar disorder.

Table 38. Marginal effect of key variables of Interest on probability of being diagnosed with PTSD (Air Force officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | 0.004*** | - | - | - | - | - | 0.006*** | 0.004*** |
| | (0.001) | | | | | | (0.001) | (0.001) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | 0.004*** | - | - | - |
| | | | | | (0.001) | | | |
| First deployment occurred in CY2006 and after | - | - | - | - | 0.007*** | - | - | - |
| | | | | | (0.002) | | | |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | 0.002** | 0.003*** | 0.001 | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to Iraq | - | 0.016*** | 0.018*** | 0.014*** | - | - | - | - |
| | | (0.002) | (0.002) | (0.002) | | | | |
| Ever deployed to an unknown/classified country | - | -0.002** | -0.001 | -0.002** | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| Ever deployed to another OEF/OIF country | - | 0.000 | 0.001* | -0.000 | - | - | - | - |
| | | (0.001) | (0.001) | (0.001) | | | | |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.002*** | - | - | - | - | - |
| | | | (0.001) | | | | | |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.003** | - | - | - | - |
| | | | | (0.001) | | | | |
| Long duration (more than 180 days) | - | - | - | 0.001 | - | - | - | - |
| | | | | (0.001) | | | | |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.000 | - | - |
| | | | | | | (0.001) | | |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.017*** | - | - |
| | | | | | | (0.005) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.019*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | 0.012*** | - | - |
| | | | | | | (0.003) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.001 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.003 | - | - |
| | | | | | | (0.002) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | 0.001 | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | -0.002 | - | - |
| | | | | | | (0.001) | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.001*** | - |
| | | | | | | | (0.000) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.001 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Predicted Probability | 0.008 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.008 | 0.007 |
| Observations | 108,575 | 108,575 | 108,575 | 108,575 | 108,575 | 108,575 | 108,575 | 108,575 |
| Standard errors in parentheses | | | | | | | | |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

Table 39. Marginal effect of key variables of Interest on probability of being diagnosed with bipolar disorder (Air Force officer population)

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| ***Deployment*** | | | | | | | | |
| Deployed in OEF/OIF missions | - 0.0013*** (0.000) | - | - | - | - | - | 0.0013*** (0.000) | -0.0011*** (0.000) |
| ***Interaction between Deployment and Deployment Period*** | | | | | | | | |
| First deployment occurred in CY2005 and prior | - | - | - | - | -0.0012*** (0.000) | - | - | - |
| First deployment occurred in CY2006 and after | - | - | - | - | -0.0016*** (0.001) | - | - | - |
| ***Deployment Location*** | | | | | | | | |
| Ever deployed to Afghanistan | - | -0.0009* (0.001) | -0.0009 (0.001) | -0.0008 (0.001) | - | - | - | - |
| Ever deployed to Iraq | - | 0.0002 (0.001) | 0.0003 (0.001) | 0.0003 (0.001) | - | - | - | - |
| Ever deployed to an unknown/classified country | - | -0.0019*** (0.000) | -0.0019*** (0.001) | -0.0019*** (0.000) | - | - | - | - |
| Ever deployed to another OEF/OIF country | - | -0.0010*** (0.000) | -0.0009** (0.000) | -0.0008* (0.000) | - | - | - | - |
| ***Deployment Frequency*** | | | | | | | | |
| Deployed more than once | - | - | -0.0004 (0.001) | - | - | - | - | - |
| ***Total Days Deployed*** | | | | | | | | |
| Short duration (less than 120 days) | - | - | - | *reference* | - | - | - | - |
| Medium duration (120 to 180 days) | - | - | - | 0.0004 (0.001) | - | - | - | - |
| Long duration (more than 180 days) | - | - | - | -0.0011* (0.001) | - | - | - | - |
| ***Interaction between Deployment Location and Period*** | | | | | | | | |
| Deployed to Afghanistan in CY2005 and prior | - | - | - | - | - | -0.0013** (0.001) | - | - |
| Deployed to Afghanistan in CY2006 and after | - | - | - | - | - | 0.0013 | - | - |

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (0.002) | | |
| Deployed to Iraq in CY2005 and prior | - | - | - | - | - | 0.0007 | - | - |
| | | | | | | (0.001) | | |
| Deployed to Iraq in CY2006 and after | - | - | - | - | - | -0.0010 | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2005 and prior | - | - | - | - | - | -0.0020*** | - | - |
| | | | | | | (0.001) | | |
| Deployed to an unknown/classified country in CY2006 and after | - | - | - | - | - | -0.0018 | - | - |
| | | | | | | (0.001) | | |
| Deployed to another OEF/OIF country in CY2005 and prior | - | - | - | - | - | -0.0007* | - | - |
| | | | | | | (0.000) | | |
| Deployed to another OEF/OIF country in CY2006 and after | - | - | - | - | - | - | - | - |
| | | | | | | - | | |
| ***Interaction between Deployment and Non-Combat Arms MOS*** | | | | | | | | |
| Deployed*Non-Combat Arms MOS | - | - | - | - | - | - | -0.0023*** | - |
| | | | | | | | (0.000) | |
| ***Interaction between Deployment and Female*** | | | | | | | | |
| Deployed*Female | - | - | - | - | - | - | - | -0.0009 |
| | | | | | | | | (0.001) |
| Observed Probability | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| Predicted Probability | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| Observations | 108,575 | 108,575 | 108,575 | 108,575 | 108,575 | 105,855 | 108,575 | 108,575 |
| Standard errors in parentheses<br>*** $p<0.01$, ** $p<0.05$, * $p<0.1$ | | | | | | | | |

Note: Service characteristics (such as MOS and pay grade), demographic characteristics (such as gender, race, marital status and age), and the start year of observation window have been controlled for in all models.

## J. SUMMARY

This chapter used multivariate analysis to determine if deployment characteristics in OEF/OIF missions were associated with the probabilities of being diagnosed with PTSD or bipolar disorder by employing eight probit models. Deployment characteristics in OEF/OIF missions included the overall effect of deployment, deployment location, frequency and days deployed. Interaction effects between deployment and deployment period, deployment location and deployment period, deployment and MOS, and deployment and gender were also included to study how the interactions between various independent variables affected the probabilities of being diagnosed with PTSD or bipolar disorder. Separate analyses were conducted for officers and enlisted personnel across the four services of the U.S. military, and for each of the two mental health conditions.

In general, the deployment effects were more pronounced among the enlisted personnel than the officers who were deployed in OEF/OIF missions. These effects were also more pronounced for PTSD than bipolar disorder.

The multivariate analyses showed that being sent for deployment in OEF/OIF missions generally increased the probability of being diagnosed with PTSD. This was evident in both enlisted personnel and officer populations, across all four branches of service. The reverse was observed for bipolar disorder. With the exception of Marine and Navy officers, deployment in OEF/OIF missions was associated with a reduced probability of being diagnosed with bipolar disorder. Deployment in OEF/OIF missions had no significant effect for Marine and Navy officers. These results supported the hypothesis that deployment in OEF/OIF missions increased the probability of being diagnosed with PTSD, as PTSD is triggered by exposure to traumatic events. However, environmental stressors did not appear to be associated with a higher probability of being diagnosed with bipolar disorder. This was probably because genetics is a stronger determinant of bipolar disorder.

The probability of being diagnosed with PTSD was generally higher for enlisted personnel and officers deployed to Iraq, compared to those deployed to Afghanistan, except for Marine and Air Force officers. With the exception of Air Force, the probability of being diagnosed with bipolar disorder was also generally higher for enlisted personnel deployed to Iraq, compared to Afghanistan.

The authors had hypothesized that the probabilities of being diagnosed with PTSD or bipolar disorder would increase with multiple deployments to OEF/OIF missions, compared to a single deployment. Interestingly, the results showed that having multiple deployments either decreased or had no significant effect on the probability of being diagnosed with the conditions, with the exception of Marine and Navy enlisted personnel for PTSD.

The probability of being diagnosed with PTSD increased with the number of days deployed for both the enlisted personnel and officers, especially for those deployed 120 to 180 days. The effects were the opposite for bipolar disorder. The number of days deployed was either not associated or associated with reduced probability of being diagnosed with bipolar disorder.

For both Army enlisted personnel and officers, the probability of being diagnosed with PTSD was higher for those first deployed in CY2006 and after, compared to those first deployed in CY2005 and prior. The differences in OEF/OIF deployment location effects between the two periods were evident for all OEF/OIF deployment locations. There was no distinctive pattern in the OEF/OIF deployment location effects between the two periods on PTSD for the other three services, or on bipolar disorder for all populations.

Army and Marine service members generally had higher probability of being diagnosed with PTSD if they were in combat arms specialty fields, compared to the other specialty fields. The effect of combat arms MOSs on the probability of being diagnosed with PTSD was greater among deployed Army and Marine enlisted personnel, compared to officers from the same services. On the other hand, Navy and Air Force service members had lower probability of

being diagnosed with PTSD if they were in combat arms specialty fields, compared to the other specialty fields.

As for bipolar disorder, Army enlisted personnel in combat arms specialty fields was associated with an increase in probability of being diagnosed with the condition, compared to the other specialty fields. For Navy and Air Force officers and Navy enlisted personnel, being in combat arms specialty fields was associated with a reduced probability of being diagnosed with bipolar disorder, compared to the other specialty fields.

Females had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to males. This was consistent across all eight populations. Among enlisted personnel across all services, there was a negative interaction effect between deployment in OEF/OIF missions and being female on the probability of being diagnosed with PTSD.

Enlisted personnel in junior pay grades had higher probabilities of being diagnosed with PTSD or bipolar disorder, compared to those in senior pay grades. This was evident for all four services, with the exception of Marine enlisted personnel where the effect of pay grade was not significant for PTSD. For officers in all four services, being in junior pay grades increased the probability of being diagnosed with PTSD, compared to those in middle and senior pay grades.

In terms of race, there were some observable trends on the probability of being diagnosed with either mental health condition. Among the enlisted personnel, whites across all services had higher probability of being diagnosed with PTSD, as compared to blacks. For bipolar disorder, white enlisted personnel across all services were also associated with a higher probability of being diagnosed with the condition, compared to other racial minority groups. There were no distinctive trends among the officers for PTSD and bipolar disorder.

Generally, married personnel had higher probability of being diagnosed with either condition for enlisted personnel for all four services, compared to non-

married. This was also observed for officers across all four services on the probability of being diagnosed with PTSD, except Marine officers.

Chapter VII will cover an in-depth discussion of the results. Limitations of this thesis and proposed recommendations will also be discussed.

# VII. CONCLUSION

## A. DISCUSSIONS

This thesis analyzed the effects of deployment, service, and demographic characteristics on the probability of being diagnosed with Post-Traumatic Stress Disorder (PTSD), schizophrenia and bipolar disorder between 2001 and 2011. As the U.S. military's efforts in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) stepped up from FY2006 to FY2010, an in-depth analysis was also conducted to determine if there was differential effects of deployments on the incidence rates of these costly mental health conditions between service members deployed in 2005 and prior, and 2006 and after.

The discussions in this chapter will largely focus on PTSD and bipolar disorder. As described in Chapter V, there was a low schizophrenia occurrence rate among both enlisted and officer populations. Thus, this condition was removed from the multivariate analysis in Chapter VI.

The authors hypothesized that the probability of being diagnosed with PTSD and bipolar disorder would increase if a service member were sent for deployment in OEF/OIF, compared to non-deployed. For PTSD, the multivariate analysis results supported this hypothesis for both enlisted personnel and officers, across all four services. This is consistent with the existing literature on the relationship between deployment and PTSD prevalence rate among the active duty service members in the U.S. military (Hoge et al., 2006; Shen et al., 2010; Vasterling et al., 2010). Deployed service members had higher chances of directly experiencing blasts from improvised explosive devices (IED) or on the battlefield, or indirectly experiencing combat stress through seeing or helping dead and injured friends. Such factors thus increased the probability of service members being diagnosed with PTSD.

As for bipolar disorder, the results did not support the above-mentioned hypothesis. Unlike current studies that showed environmental stressors could

affect the risk of developing bipolar disorder (Bebbington et al., 1993; Goldberg & Gamo, 2005), the results showed that deployment in OEF/OIF missions either had no effects or decreased the probability of being diagnosed with the condition, for both enlisted personnel and officers. One possible explanation is that, similar to schizophrenia, bipolar disorder is largely determined by genetic inheritance. Service members who showed symptoms, or assessed to have higher probability of developing bipolar disorder, would be filtered out during the selection processes for active duty recruitment or overseas deployment.

The multivariate analysis results also supported the hypothesis that deployment to Iraq is associated with higher probability of being diagnosed with PTSD or bipolar disorder, *relative* to other OEF/OIF countries, including Afghanistan. The location variables can be considered as proxy for levels of combat exposure. The findings were consistent with Hoge et al. (2004), which found that service members who deployed to Iraq had a higher frequency of contact with enemy and exposure of combat experiences, as compared to those deployed to Afghanistan. The chances of experiencing traumatic events should be lower in unknown/classified country or other OEF/OIF country as those countries are likely to be staging countries, or locations executing administrative or logistics support. Therefore, the occurrence of traumatic events should be lower.

The authors hypothesized that the probability of being diagnosed with PTSD increased with higher frequency of deployments. For PTSD, this hypothesis was supported only in the Marine and Navy enlisted populations. The hypothesis was not supported for bipolar disorder. This might reflect a selection problem; that is, a service member diagnosed with mental health conditions was less likely to be deployed again.

The results also supported the hypothesis that with more days deployed, the probability of being diagnosed with PTSD increased. This was evident among service members with 120 to 180 days deployed, compared to those with fewer than 120 days, with the exception of Navy enlisted personnel. One reason could

be that having more days in deployment increased the chances of being exposed to traumatic or stressful events. The results were not consistent for service members with more than 180 days deployed, compared to those with fewer than 120 days. This might again reflect a selection problem—a deployed service member diagnosed with PTSD was less likely to be deployed for longer durations, or would have been sent home earlier.

As stated earlier, the U.S. military's war efforts had stepped up from FY2006 to FY2010. The increased tempo in operations was likely to increase mental stress on the deployed troops. In addition, the Iraq Study Group reported in December 2006 that the situation in Iraq had deteriorated (Tanielian & Jaycox, 2008). Around the same time, the former Iraqi president, Saddam Hussein, was executed, leading to increased instability in the region. This inferred that service members deployed in and after CY2006 could have higher chances of encountering traumatic events. The results supported the hypothesis for the Army, where deployment period had a significant effect on the probability of being diagnosed with PTSD among Army service members. The probability of being diagnosed with PTSD was higher for Army service members who were first deployed in CY2006 and after, compared to CY2005 and prior. Notably, there is no significant difference between the two periods for the Marine Corps. This is despite both the Army and the Marine Corps being stretched to support the OEF/OIF missions, and exposed to similar combat environments due to their mode of operations. Many factors could lead to this difference in results. For example, the number of PTSD cases diagnosed could be affected by the different type of intervention programs available, culture in the service, and the level of stigma on service members with PTSD. Other reasons, such as the demographic mix of the service members, or changes in specific job operations could also play a part. No significant differences between the two periods were observed for the other populations for PTSD, as well as for bipolar disorder, for all four services.

As hypothesized, service members in combat arms specialty fields generally had a higher probability of being diagnosed with PTSD, compared to other specialty fields. This was evident in the Army and Marine Corps. Due to the nature of the job assignments, Army and Marine service members were more likely to be involved in direct engagement with enemies or witness injuries or deaths up close, than were the Navy and Air Force members. Another reason could be data limitations, as large proportions of Navy and Air Force service members were identified as having other Military Occupational Specialty (MOS).

Consistent with prior studies, females had a higher probability of being diagnosed with PTSD and bipolar disorder, compared to males (Kennedy et al., 2002; Krishkan, 2005; Shen et al., 2010; Shippee et al., 2011). This could be because females were more willing to actively seek proper medical treatment than males, or that females had a higher propensity of acquiring PTSD after experiencing a traumatic event.

Other than the key variables of interest, there were other findings worthy of discussion. First, being in junior pay grades generally was associated with a higher probability of being diagnosed with PTSD or bipolar disorder. Service members in junior pay grades generally had shorter time in service and could have fewer combat experiences, and thus lower levels of mental toughness.

Married service members had a higher probability of being diagnosed with PTSD and bipolar disorder, compared to non-married. One reason could be that married service members were more likely to actively seek medical help, when their spouses noticed the symptoms and encouraged them to seek treatment. Conversely, the probability of a close friend or family member to do the same for non-married service members might be lower.

## B. LIMITATIONS

This thesis has several limitations. First, it used the observation window approach to reduce selection bias, where only deployment information during the first four years of service was tracked (for service members who were already in service prior to 2000, the first year of data, we observe them during the first four years of data). This meant that the military population studied was generally younger than the general U.S. military population. A standard timeframe was also used to define the observation window across four services, for both enlisted personnel and officers. It might not be suitable for observation of deployment characteristics across all populations, as the training cycle and deployment patterns differed among the services and pay grades. Although the observation window approach had its limitations, it was chosen because of its merits. As mentioned in Chapter IV, the observation window allowed for consistent reference points across all populations in observing independent variables, and ensured that deployment characteristics were independent of the outcomes of interest (PTSD and bipolar disorder).

Second, the medical diagnosis information used for this thesis was limited to only information from TRICARE. The number of PTSD, schizophrenia and bipolar cases might be understated for two reasons. The first reason is that the data did not capture service members who did not seek medical treatment, or those who sought treatment from institutes not covered under TRICARE. This could be due to fear that their career progression might be affected by their conditions. The second reason is that TRICARE only applies to active duty and retired service members. After separation from the military under other than dishonorable conditions, veterans' health care is provided by the Department of Veterans Affairs (VA) health care system, and not TRICARE. Thus, the number of cases might also be understated because mental health conditions diagnosed for the veteran population would not be captured in the data, unless they were first diagnosed during active duty.

Third, the data did not capture information on the specific assignments or the level of combat exposure for each deployment. It was difficult to determine whether the effect on mental health conditions was due to the deployments or higher levels of combat exposure and stress. Instead, Afghanistan and Iraq were used as proxies for deployment locations with higher levels of combat stress. Military Occupation Specialty (MOS) was also included as a proxy for the likelihood of encountering traumatic events, using the combat arms specialty fields to represent assignments with higher levels of combat exposure.

Fourth, there were data limitations as mentioned in Chapter III. Some observations had missing information or data entry errors. Due to the categorization of MOS used, the majority of Navy and Air Force service members were categorized in "other MOS." These might have an impact on the precision of the analysis.

## C. RECOMMENDATIONS

Future research can focus on using data with detailed information on the actual levels of combat exposure and intensity, and relate that to the probability of being diagnosed with mental health conditions. This will help to better identify the specific triggers for PTSD, schizophrenia and bipolar disorder, such as the types of combat experiences and environment. One possibility is to obtain information (such as specific job assignment, level and types of combat exposure) through post-deployment questionnaires. Detailed classifications of the deployment locations can also be included, as the intensity of combat warfare for each area may differ within the same country.

## D. CONCLUSIONS

Statistics have shown that the number of cases of PTSD and bipolar disorder have been on the rise over the years, especially with the increase in tempo of the Global War on Terrorism (GWOT) after CY2006. Sustained operations have strained the U.S. military. To sustain the requirements in GWOT, more service members were deployed with longer deployment durations and

multiple deployments (Hosek, Kavanagh, & Miller, 2006). The demands of the operations have led to higher incidences of mental health conditions among the service members. These mental health disorders, in turn, had a direct impact on the service members and their families. Treatment costs, as well as indirect costs, could be substantial to both the military and society.

This thesis used data on almost 100% of the active duty population over the ten years of study. This was equivalent to almost three million active duty enlisted personnel and officers. While the coefficient estimates from the multivariate analyses were small in magnitude, they represented substantial numbers on the ground. Military planners can use the information from the multivariate analyses and review the personnel planning for future overseas deployments. For example, the days deployed for each service member should be considered carefully to reduce the probability of developing PTSD.

The U.S. military can also do more for current active duty service members who returned from deployment, or are returning from overseas deployment. Instead of passively waiting for affected service members to seek treatment of mental health conditions, a more proactive approach can be adopted. Periodic mental health screenings can be conducted for all service members to better identify symptoms and provide prompt medical treatment.

It is important for affected service members to seek prompt medical treatment. The U.S. military should look into ways to encourage them, such as family and friends support programs, and addressing concerns that having mental health conditions could affect their career progression. Given the continuing U.S. military presence in other parts of the world, the Department of Defense (DoD) needs to continually focus on active duty service members' well-being, so that the U.S. military can maintain adequate end strength for future operations.

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# APPENDIX. MILITARY OCCUPATIONAL SPECIALTY CATEGORIES

The occupational codes for each service are categorized into six groups: combat arms, combat service, service support, aviation, medical and others, as shown in Table 40. For a detailed description of each code by occupational title, refer to the DoD Occupational Conversion Index (DoD 1312. 1-I).

Table 40. Military occupational specialty code grouping

| | |
|---|---|
| **Air Force** | |
| Combat Arms | 1A, 1B, 1C, 1N, 1T, 1S, 1W |
| Combat Service | 3C, 3S, 8A, 8R, 2E, 2W, 3E |
| Service Support | 2A, 2F, 2G, 2M, 2P, 2R, 2S, 2T, 3A, 3H, 3M, 3N, 3P, 3U, 3V, 5J, 5R, 6C, 6F, 7S, 8C |
| Medical | 4X, 4Y |
| **Army** | |
| Combat Arms | 11, 12, 13, 14, 18, 21 |
| Combat Service | 25, 31, 35, 74 |
| Service Support | 27, 36, 42, 44, 88, 89, 91, 92, 94 |
| Medical | 60, 61, 62, 63, 64, 65, 66, 67 |
| **Marine Corps** | |
| Combat Arms | 03, 08, 13, 18 |
| Combat Service | 05, 06, 21, 23, 25, 26, 28, 57 |
| Service Support | 01, 02, 04, 09, 11, 27, 30, 31, 33, 34, 35, 40, 41, 43, 44, 46, 55, 58, 59 |
| Aviation | 60, 61, 62, 63, 64, 65, 66, 68, 70, 72, 73, 75 |
| **Navy** | |
| Combat Arms | BM01, FC11, FC13, GM08, MN12, OS03, QM02, TM07, 53, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99 |
| Combat Service | DC48, EM33, EM46, EN43, EO57, ET14, ET15, ET16, ET17, ET33, ET47, FC16, FT11, FT13, GS41, IC47, IS39, MM33, MM42, MM45, MR44, MT33, CT091, STG04, STG05, STG06, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70,71, 72, 73, 74, 75, 76, 77, 78, 79 |
| Service Support | BU59, CE56, CM58, DK29, HT49, IT23, IT27, JO32, LI36, MA20, MS35, MU38, NC21, PN26, RP24, SH31, SK28, YN25, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59 |
| Aviation | AZ63, AD64, AO68, AC69, AB70, AE71, AM72, PR73, ABE70, ABF70, ABH70, AME72, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89 |
| Medical | HM84, DT87, 00, 02, 02, 03, 04, 05, 06, 07, 08, 09 |

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